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COLOR-MARKING WHITE GEESE FOR DETERMINING MIGRATION ROUTES[1]

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INTRODUCTION

One of the best means of following a wildlife population is to have an adequate sample of that population marked. The usual method of marking waterfowl is with the use of metal leg bands. This practice dates back to about the turn of the century when birds were first banded for migration studies. Since then the number of birds banded annually has steadily increased, and the knowledge of waterfowl migrations has been broadened proportionately.

Marking birds with metal leg bands leaves much to be desired for conducting migration studies. Usually only one recovery is obtained from a banded bird, when that bird is killed or found dead. Normally, the majority of those banded will disappear from the population unreported. It was felt that by color-marking waterfowl repeated observations could be made of the birds as they moved along the flyway.

ACKNOWLEDGMENTS

Acknowledgment with appreciation is made to the other members of the waterfowl study project who helped with the study, especially A. E. Naylor, J. R. LeDonne, E. G. Hunt, Ralph Wells, and F. Dale Horn. Thomas Horn, refuge manager, and other personnel of the Tule Lake National Wildlife Refuge assisted.

The excellent co-operation of the observers who reported seeing the colored geese is especially appreciated. In this regard personnel of the Canadian Wildlife Service, the Provincial Game Branches, and members of the Pacific Flyway Technical Committee were especially helpful.

METHODS

Since the lesser snow goose, *Chen hyperborea hyperborea* and the Ross' goose, *Chen rossii* were among the species of waterfowl under study, it was decided that the white plumage of these birds would form an ideal background for any type of color-marking that could be devised. Wadkins (1948) had reported the use of dyes for marking pheasants, and this technique seemed applicable for marking white geese.

During the winter of 1954-55 various dyes were tested on lesser snow geese that were held under penned conditions. Most of the dyes covered

[1] Submitted for publication January, 1959. This is a contribution of Federal Aid in Wildlife Restoration Act Project, California W-30-R, "A Study of Waterfowl in California."

the birds thoroughly and the colors proved to be quite striking. However, it soon became apparent that only a few of these dyes retained their colors with any degree of permanency. It had been planned that the first white geese to be dyed would be used for a study to trace the migration of these geese from the California wintering grounds to the northern breeding areas. Therefore, it was necessary that any dye that was used would have to retain its color at least for a few months during the spring while the geese moved up the Pacific Flyway. After the geese were on the breeding grounds, they would lose the dyed color when their feathers were replaced during the postnuptial molt. Therefore, the technique of dying plumage that is annually replaced is practical only for certain short-term migration studies.

The tests for checking the permanency of the colors revealed three dyes that could be considered satisfactory for the marking operations. These dyes were Rhodamine B (pink), malachite green, and picric acid (yellow). The pink dye was prepared by dissolving 10 grams of Rhodamine B in five gallons of isopropyl alcohol and adding an equal amount of water to the solution. The green dye was prepared by dissolving 15 grams of malachite green in the same amounts of alcohol and water as used above. The yellow dye was prepared by making a saturated solution of picric acid in isopropyl alcohol and diluted with water as above. By mixing about two parts of the pink solution to one part of the green dye, it was possible to obtain a vivid purple color.

During the spring of 1955, 859 migrating geese were trapped and banded near Tulelake, California. From this group of birds, 83 white geese were color-dyed. During March, 42 lesser snow geese were dyed pink. These birds were considered to be early migrants. By late April, most of the lesser snow geese had moved on, but 33 were caught from the few remaining flocks. These geese were dyed with malachite green to distinguish them from those colored earlier. Over the entire banding period eight Ross' geese were trapped and dyed yellow.

The geese were colored by dipping the outstretched wings and the tail into the dye solution. When the bird closed its wings, the sides of the body became colored. The dye spread rapidly, and as the goose preened and ruffled its feathers it diffused over the entire bird. If the entire bird was immersed in the solution, the body down became soaked and the bird lost too much body heat from the cooling effect of evaporating alcohol, resulting in death.

The geese were held overnight in a warm building so that they were thoroughly dry before being released. After they were released, they immediately joined the other geese in the area which accepted them as one of their kind.

REPORTS OF COLORED GEESE—1955

Technicians in the other states of the Pacific Flyway and Canadian officials were notified of the study and asked to report any of the colored geese that might be seen in their respective areas. Some of the colored geese remained in the Tulelake area well into May. On May 11 about 15 of the green-colored geese and four of the pink geese were still there. Out-of-state reports for the pink geese showed two birds at Burns, Oregon, in April; two separate observations of single geese in Alberta in May; two observations of single geese (probably the same bird seen

twice) along the Mackenzie River in May; two separate observations of single birds in May near the Arctic Coast; one goose in Alaska; and, two geese seen in June on Banks Island north of the Arctic Coast. The green geese were reported only once after they left California. On July 7 while banding geese on Banks Island, E. H. McEwen of the Canadian Wildlife Service caught one of the green birds. This bird was trapped in the same general area where the two pink geese had been seen.

It was expected that the birds would retain their color until they molted on the breeding grounds. However, one of the pink geese must not have molted or was still in a very gradual molt when it returned to Tulelake during the first week in November. The color of this bird was faded but still discernible. That same fall one of the green-colored geese was shot in the Sacramento Valley of California still retaining some of its color.

After leaving Tulelake the Ross' geese were seen on June 7 flying over the Hay River near Great Slave Lake. Eight geese were reported —all that had been colored. Another yellow goose was reported as seen on the Arctic Coast between the Anderson and Mackenzie Rivers in May. This bird was seen by Eskimos and reported by Doctor Hohn of the University of Alberta. It is doubtful that this bird was one of the eight Ross' geese colored at Tulelake as it was much farther north and seen at an earlier date than the eight yellow geese reported from the Hay River. During the winter of 1954-55, three Ross' geese were colored yellow and released in the Sacramento Valley. Two were later killed by a hunter, and the bird that was reported by Doctor Hohn could have been the lone survivor.

From previous band recoveries, it was known that some of the snow geese leaving Tulelake in the spring migrate to Alaska and Siberia to nest. However, only one of the colored birds was reported from that portion of the flyway, and it is probable that the sample of colored birds was too small to adequately represent the Tulelake population.

Table 1 presents a summary of the observations that were reported for these colored geese. These observations also are shown with the letter symbols on the map of Figure 1.

COLORED ROSS' GEESE—FALL, 1955

Goose banding was resumed during the fall of 1955. These operations resulted in trapping and banding 2,183 geese. Since 53 of these birds were Ross' geese, it afforded an opportunity to check the extent of their winter range. These birds were dyed yellow and on November 11 and 12 were released on the Tulelake National Wildlife Refuge. The weather turned cold and stormy and large numbers of ducks and geese departed for the California wintering grounds to the South. Two days after the first release two yellow Ross' geese were seen on the Butte Sink area of the Sacramento Valley. Later more birds were seen and by the end of November the first report came from the San Joaquin Valley.

During December, yellow Ross' geese were reported throughout the Central Valley. They were seen also on the Trinity River. Four birds were observed around the Tule Lake Refuge until the middle of December. In addition, five colored geese were found dead and two were seen crippled on this area. Four yellow geese were killed by hunters in the

FIGURE 1. Map showing the generol location of each sight record of the white geese that were colored during the spring of 1955 and 1956. (Drawing by Cliffa Carson). The 1955 records are designated by the corresponding letter symbol listed in Table 1. The 1956 records are designated by the corresponding numerical symbol listed in Table 3.

TABLE 1

Summary of Observations of the Geese Color-Marked at Tulelake, California—Spring 1955

Map symbol	Where seen	Date seen	Reporter and remarks
	42 Lesser Snow Geese Colored Pink March 24-April 5, 1955		
A	Burns, Oregon	April 25	Two seen with other snow geese. Reported by Chester E. Kebbe, Oregon Game Commission
B	Lake McGregor, Strathmore, Alberta	May 3	One seen in a flock of 25 snow geese. Reported by G. Freeman, Ducks Unlimited
C	Buffalo Lake, LaComb, Alberta	May —	One seen. Reported by G. Hortin Jensen, U. S. Fish & Wildlife Service
D	Toker Point, Aretic Coast between Anderson and Mackenzie Rivers, N.W. Territories	May —	One seen by Eskimos, reported by Dr. Hohn, Univ. of Alberta to H. R. Webster, Canadian Wildlife Service
E	75 miles north of Fort Good Hope on the Mackenzie River, N. W. Territories	May 16	One seen by Baptiste Chae (Treaty Indian) with flock of snow geese. Reported by W. E. Stevens to T. S. Hennessy, Canadian Wildlife Service
F	Same locality as above	May 18	One seen by Gabriel Kelly (Treaty Indian). Could have been same bird reported above. Reported by W. E. Stevens to T. S. Hennessy, Canadian Wildlife Service
G	40 miles north of Aklavik, Mackenzie River Delta, N. W. Territories	May 23	One seen by Eskimo in a flock of 12 snow geese. Reported by W. E. Stevens to David A. Munro, Canadian Wildlife Service
H	Between Cape Kellett and Sachs Harbor on Banks Island, Franklin District, N. W. Territories	June 7	Two seen. Reported by E. H. McEwen to T. S. Hennessy, Canadian Wildlife Service
I	Hamilton, Alaska, lat. 62° 50′ N., long. 164° 10′ W.	Spring of 1955	One seen by Eskimos (reported as orange). Reported by Gordon Watson and H. A. Hansen, U. S. Fish & Wildlife Service, Alaska
—	Tule Lake National Wildlife Refuge, Tulelake, California	First week of November	One seen several times by 30-R personnel, W. C. Rienecker and E. G. Hunt
	33 Lesser Snow Geese Colored Green April 29, 1955		
J	Between Cape Kellett and Sachs Harbor on Banks Island, Franklin District, N. W. Territories	July 7	One caught during banding operations by E. H. McEwen. Reported by Hennessey, Canadian Wildlife Service
	Eight Ross' Geese Colored Yellow April 5, 1955		
K	Hay River near Great Slave Lake, N. W. Territories	June 7	Eight seen flying together by Hubert Kloss. Reported by W. E. Stevens to T. S. Hennessey, Canadian Wildlife Service

Sacramento Valley and two were shot in the San Joaquin Valley during the hunting season.

Although Ross' geese are found in Imperial Valley during the winter, none of the colored geese were seen there. This may indicate that they, like most waterfowl wintering in Imperial Valley, migrate east of the Sierra Nevada mountains instead of through the Tulelake-Central Valley route.

By late February and early March the Ross' geese were evidently again starting northward, as two yellow ones were reported from the Pit River Valley. By late March, yellow geese were no longer seen in the Central Valley. Although a special effort was made to observe these

yellow dyed geese at Tulelake on their return migration, none were seen. Since they were seen in March and April near Burns, Oregon, it is possible that these geese passed to the east of Tulelake on their northward flight.

A summary of the observations made on these yellow colored Ross' geese is shown in Table 2 and also, graphically presented on the map, Figure 2.

REPORTS OF COLORED GEESE—1956

In the spring of 1956, color-marking operations were carried on again at Tulelake. During March and April, 302 lesser snow geese were dyed pink, 123 were dyed green, and in order to try out another color,

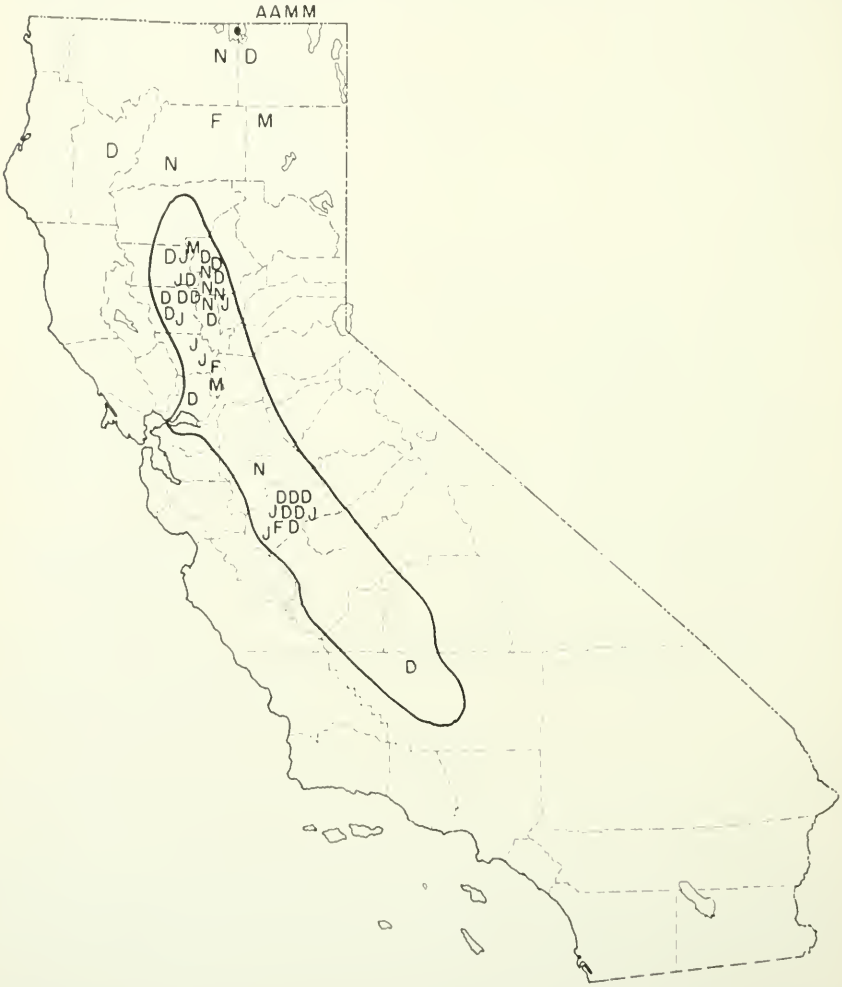

FIGURE 2. Map of California (with the Central Valley outlined) showing the general location of each sight record of the Ross' geese that were colored in the fall of 1955. (Drawing by Cliffa Carson). The symbol showing each sight record is the first letter of the month when the observation was recorded (see Table 2).

TABLE 2

Summary of Observations of Ross' Geese Color-Marked at Tulelake, California—November 11-12, 1955

Where seen	Date seen	Reporter and remarks
Butte Sink, Colusa-Sutter Counties	Nov. 13, 1955	Two seen with other Ross' geese by David Marshall, U. S. Fish and Wildlife Service
Butte Sink, Colusa-Sutter Counties	Nov. 16, 1955	Two and possibly three seen by David Marshall, U. S. Fish and Wildlife Service
Tule Lake National Wildlife Refuge, Siskiyou County	Nov. 13-19, '55	Sixteen remained in area. Reported by Thomas Horn, U. S. Fish and Wildlife Service
West Butte Gun Club, Sutter County	Nov. 20, 1955	Five seen by club members
One mile northwest of Gray Lodge Waterfowl Mgt. Area, Butte County	Nov. 20, 1955	One seen by Frank Hackett. Reported by William Campbell, Calif. Dept. of Fish and Game
Few miles southeast of Redding, Shasta County	Nov. 21, 1955	One seen with 30 other white geese. Reported by Fred Ross, Calif. Dept. of Fish and Game
Tule Lake Nat'l Wildlife Refuge, Siskiyou County	Nov. 20-26, '55	Twelve still remained in area. Reported by Thomas Horn, U. S. Fish and Wildlife Service
San Joaquin River, 10 miles west of Modesto, Stanislaus County	Nov. 27, 1955	Fifteen flying south in a flight of other geese. Seen by fisherman. Reported by Warden G. W. Magladry, Calif. Dept. of Fish and Game
Tule Lake National Wildlife Refuge, Siskiyou County	Dec. 1, 1955	Four still remained in area. Reported by Thomas Horn, U. S. Fish and Wildlife Service
Willow Creek Gun Club, Colusa County	Dec. 4, 1955	One seen with other Ross' geese. Reported by R. M. Glahn and W. F. Crissey, U. S. Fish and Wildlife Service
Trinity River near Douglas City, Trinity County	Dec. 5-10, '55	Two seen on the Trinity River. Reported by Fred Ross, Calif. Dept. of Fish and Game
Colusa Nat'l Wildlife Refuge, Colusa County	Dec. 10, 1955	Five seen on refuge. Reported by Max Knox, Calif. Dept. of Fish and Game
Two miles north of Merced Nat'l Wildlife Refuge, Merced County	Dec. 10, 1955	One seen by Warden H. R. Hale, Calif. Dept. of Fish and Game
Gray Lodge Waterfowl Mgt. Area, Butte County	Dec. 10, 1955	One seen by Robert Lechleitner, Univ. of California
Gray Lodge Waterfowl Mgt. Area, Butte County	Dec. 11, 1955	One seen. Reported by John Cowan, Calif. Dept. of Fish and Game
Modesto Gun Club, Merced County	Dec. 11, 1955	One seen by William J. Silva, Calif. Fish and Game Comm.
Sacramento Nat'l Wildlife Refuge, Glenn County	Dec. 12, 1955	Two seen on aerial waterfowl survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
Gray Lodge Waterfowl Mgt. Area, Butte County	Dec. 12, 1955	Two seen on aerial waterfowl survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
Butte Sink, Colusa-Sutter Counties	Dec. 12, 1955	One seen on aerial waterfowl survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
Sutter Nat'l Wildlife Refuge, Sutter County	Dec. 12, 1955	Two seen on aerial waterfowl survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
Northern part of Kern County	Dec. 15, 1955	Three seen by duck hunters. Reported by Warden D. A. Clanton, California Dept. of Fish and Game
Little Holland Island, Solano County	Dec. 16, 1955	One seen by Richard Leverich, Dixon
Merced Nat'l Wildlife Refuge, Merced County	Dec. 16, 1955	Three seen by refuge personnel. Reported by G. H. Crawford, U. S. Fish and Wildlife Service
Merced Nat'l Wildlife Refuge, Merced County	Dec. 17, 1955	Two seen by H. J. Smoke, Calif. Dept. of Fish and Game
Merced Nat'l Wildlife Refuge, Merced County	Dec. 18, 1955	One seen by H. J. Smoke, Calif. Dept. of Fish and Game
Merced Nat'l Wildlife Refuge, Merced County	Dec. 19, 1955	One seen by Wm. Anderson, Calif. Dept. of Fish and Game
One mile northwest of Gray Lodge Waterfowl Mgt. Area, Butte County	Dec. 18, 1955	Two seen. Reported by B. Knowles, Calif. Dept. of Fish and Game

TABLE 2—Continued

Summary of Observations of Ross' Geese Color-Marked at Tulelake, California—November 11-12, 1955

Where seen	Date seen	Reporter and remarks
Tule Lake National Wildlife Refuge, Siskiyou County	Dec. 18, 1955	One still remained in area. Reported by Thomas Horn, U. S. Fish and Wildlife Service
Pennington Duck Club, Sutter County	Dec. 19, 1955	One seen by Harlan Howard, Yuba City
3 miles southwest of Willows, Glenn County	Jan. 5, 1956	One seen with 5 white geese and 150 cackling geese by J. E. Chattin, U. S. Fish and Wildlife Service
Conway Ranch, Yolo By-Pass, Yolo County	Jan. 7, 1956	Two seen during aerial survey by J. E. Chattin, U. S. Fish and Wildlife Service and F. M. Kozlik, Calif. Dept. of Fish and Game
Modesto Gun Club, Merced County	Jan. 8, 1956	Two seen during aerial survey by J. E. Chattin, U. S. Fish and Wildlife Service and F. M. Kozlik, Calif. Dept. of Fish and Game
Northwest of Knights Landing, Yolo County	Jan. 9, 1956	One seen during aerial survey by J. E. Chattin, U. S. Fish and Wildlife Service and F. M. Kozlik, Calif. Dept. of Fish and Game
Merced Nat'l Wildlife Refuge, Merced County	Jan. 11, 1956	One seen during aerial survey by J. R. LeDonne and A. W. Miller, Calif. Dept. of Fish and Game
Butte Sink, Colusa-Sutter Counties	Jan. 11, 1956	One seen during aerial survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
South of Colusa National Wildlife Refuge, Colusa County	Jan. 11, 1956	One seen during aerial survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
Gray Lodge Waterfowl Mgt. Area, Butte County	Jan. 11, 1956	Two seen by A. E. Naylor and E. G. Hunt, Calif. Dept. of Fish and Game
Grasslands Area, Merced County	Jan. 15, 1956	Four seen during aerial survey by David Marshall and R. M. Glahn, U. S. Fish and Wildlife Service
Harry Harr Ranch, Glenburn, Shasta County	Feb. 25, 1956	One seen by Mrs. R. E. Ratledge, Glenburn
West of Merced National Wildlife Refuge, Merced County	Feb. 27, 1956	One seen during aerial survey by E. Kridler and R. M. Glahn, U. S. Fish and Wildlife Service
South of Highway 40, Yolo By-Pass, Yolo County	Feb. 28, 1956	One seen during aerial survey by E. Kridler and R. M. Glahn, U. S. Fish and Wildlife Service
McGowan Ranch, east of Butte City, Butte County	Mar. 8, 1956	One seen during aerial survey by E. Kridler and R. M. Glahn, U. S. Fish and Wildlife Service
Near Bieber, Lassen County	Mar. 14, 1956	One seen by T. Garrett, U. S. Fish and Wildlife Service
South of Highway 40, Yolo By-Pass, Yolo County	Mar. 16, 1956	Two seen during aerial survey by E. Kridler and R. M. Glahn, U. S. Fish and Wildlife Service
Sacramento and San Joaquin Valleys	Mar. 23, 1956	None seen during special aerial survey by E. Kridler and R. M. Glahn, U. S. Fish and Wildlife Service
Near Burns, Harney County, Oregon	Mar. 27, 1956	One seen by David Marshall, U. S. Fish and Wildlife Service
Near Burns, Harney County, Oregon	Mar. 31, 1956	One seen by Mrs. Walter McEwen
Near Burns, Harney County, Oregon	Apr. 11, 1956	Two seen by C. E. Kebbe, Oregon Game Department
Near Burns, Harney County, Oregon	April 12, 1956	Three seen by W. C. Lightfoot, Oregon Game Department

five were colored purple. Over the entire spring trapping period only five Ross' geese were caught, which were dyed yellow. In all, 435 white geese were colored which was more than five times that of the previous spring.

The technicians along the flyway were again alerted and the sight records that were reported are summarized in Table 3.

More observations of colored birds were recorded than previously. The geese using the western portion of the Pacific Flyway were indicated by reports coming from Oregon, Washington, British Columbia and Alaska. No records were received from Siberia, but with reports coming from Nome, Teller and Kotzebue, some colored geese probably accompanied the snow geese that cross the Bering Strait to reach their nesting grounds. Most of the reports of the color-marked birds came from the eastern portion of the flyway. The larger numbers of observations could mean that more colored birds used that part of the flyway, but it is more likely that there were more people to see the birds and report them. These observations traced the snow goose migration up through eastern Oregon, Montana, Alberta, Northwest Territories, and to the Arctic Coast.

Two interesting observations from Alberta are numbers 44 and 45 (Table 3). It is quite possible that these two sightings which were made independently, could have involved the same group of birds. Mr. AAstrup reported the geese leaving Lake McGregor on May 3, 1956, while Mr. Freeman made his observation at Namaka that same evening on newly arrived birds. Namaka is about 30 miles northwest of Lake McGregor. Both observers reported that two of the colored geese seemed to be a pair.

For observation number 65, Table 3, it does not seem possible that 30 pink geese would be concentrated in one flock. Mr. Stevens questioned this sight record before sending it in, but he was unable to obtain any additional information.

It was noted earlier that some of the geese colored during the first year's operation, returned that fall still wearing some of the dye. During the fall of 1956, similar incidents were noted. The partially pink goose reported in observation number 21 (Table 3) was probably returning south with only part of the colored feathers molted. The first part of November project personnel at Tulelake saw a partially colored pink goose while carrying on the fall banding program. This bird was trapped on November 9 and examination showed that it had not yet molted all of its feathers. The old feathers still retained the pink color. Another goose that was still partly colored pink was shot in the Sacramento Valley during the 1956 hunting season. Other fall reports of colored geese came from outside the Pacific Flyway.

Two pink geese were reported in Terrebone Parish, Louisiana, on October 29, 1956, and a green-colored goose, thought to be a blue goose *Chen caerulescens*, was reported from Orange County, Texas, on October 20, 1956. Evidently some of the lesser snow geese do not complete their post-nuptial or summer molt until they are on the wintering grounds. It also indicated, just as band returns have shown, that some birds shift from one flyway to another.

TABLE 3

Summary of Observations of the Geese Color-Marked at Tulelake, California—Spring, 1956

Map symbol	Where seen	Date seen	Reporter and remarks
	Western Portion of Pacific Flyway		
1	Halsey, Oregon	May 1, 1956	One pink goose seen in a flock of 30 geese by Buster Wassom, reported by Chester E. Kebbe, Oregon Game Commission
2	Blaine, Washington	April 30, 1956	One pink goose seen in a flock of 60 geese by Mrs. Lucille Klein, reported by Dr. J. L. Buckley, University of Alaska
3	Puget Sound between the mouth of the Skagit River and Whidby Island, Washington	May 17, 1956	One pink goose seen in a flock of 25 snow geese, reported by J. B. Lauckhart, Washington Dept. of Game
4	Fraser River, two miles below New Westminister, British Columbia	May 2, 1956	Two pink geese in a flock of 150 geese seen by three observers, reported by James Hatter, B. C. Game Commission
5	Mouth of Fraser River, three miles west of Ladner, British Columbia	May 23, 1956	One pink goose, reported by James Hatter, B. C. Game Commission
6	Junction of the Harrison River and the Fraser River, British Columbia	May 23, 1956	Two pink geese, reported by James Hatter, B. C. Game Commission
7	Fraser Flats, six miles north of Prince George, British Columbia	May 15, 1956	One pink goose with 10 other geese seen by Dan Fuite, reported by B. C. Game Commission, F. R. Butler
8	Minto Lake, Alaska, lat. 65° N., long. 148° 50′ W.	May 8, 1956	One pink goose seen in a flock of 125 geese by Lou Rowenski, Univ. of Alaska. Reported by Henry A. Hansen, U. S. Fish and Wildlife Service, Alaska.
9	Teller, Alaska, lat. 65° 10′ N., long. 167° 20′ W.	May 11, 1956	One pink snow goose reported by Sig Olson, U. S. Fish and Wildlife Service, Alaska
10	Stevens Village, Alaska, lat. 66° N., long. 149° W.	May 15, 1956	One pink goose seen with a flock of white geese by Mrs. Wm. Summers, reported by Sig Olson, U. S. Fish and Wildlife Service
11	Hoonah Sound, Alaska, lat. 58° 10′ N., long. 135° 30′ W.	May 18, 1956	One pink goose seen with three snow geese and 40 Canada geese by O. M. Rinderkneckt, reported by Henry A. Hansen, U. S. Fish and Wildlife Service
12	Cape Blossom, Kotzebue Sound, Alaska, 66° 50′ N., long. 162° 40′ W.	May 21, 1956	One pink goose with about 20 snow geese, mistaken for a flamingo, shot at but missed by Eph Wheeler. Reported by Sig Olson, U. S. Fish and Wildlife Service
13	Nome, Alaska	May 22, 1956	One green goose seen in a flock of snow geese by Eskimo, Arthur Coffin. Reported by City Clerk, Carrie McLain to Clarence Rhode, U. S. Fish and Wildlife Service, Alaska
14	Mouth of Kobuk River, Kotzebue Sound	May 23, 1956	One pink goose reported by Sig Olson, U. S. Fish and Wildlife Service
15	Teller, Alaska	May 23, 1956	One pink goose seen in a flock of 29 geese by Miss Sara Miller, reported by Dr. J. L. Buckley, Univ. of Alaska
16	Teller, Alaska	May 24 to May 26, 1956	Three pink geese seen by Mrs. John Weyanna. Several pink geese seen, one shot. A "pretty blue goose" seen by Johnny Weyanna (12 years old). Above records reported by Mrs. Mary M. Tweet to Dr. Buckley
17	Hamilton, Alaska, lat. 62° 50′ N., long. 161° 10′ W.	Spring of 1956	One "orange" goose seen by Eskimos. Reported by Gordon Watson and Henry A. Hansen, U. S. Fish and Wildlife Service

TABLE 3—Continued

Summary of Observations of the Geese Color-Marked at Tulelake, California—Spring, 1956

Map symbol	Where seen	Date seen	Reporter and remarks
18	Hamilton, Alaska	Spring of 1956	One pink goose with band No. 587-11209 shot by Eskimos. Reported by Gordon Watson and Henry A. Hansen, U. S. Fish and Wildlife Service
19	Chaniliuit, Alaska, lat. 63° N., long. 164° 30′ W.	Spring of 1956	One "red" goose seen by Eskimos. Reported by Gordon Watson and Henry A. Hansen, U. S. Fish and Wildlife Service
20	Hoonah Sound, Chichagof Island, Alaska, lat. 58° 10′ N., long. 135° 50′ W.	June 13, 1956	Two pink geese seen by Alex Brogle. Reported by Henry A. Hansen, U. S. Fish and Wildlife Service
21	Mud Bay, Chichagof Island, Alaska, lat. 58° 20′ N., long. 136° W.	Sept. 10, 1956	Partially pink goose seen by John Ritter. Reported by Henry A. Hansen, U. S. Fish and Wildlife Service
	Eastern Portion of Pacific Flyway		
22	West side of Goose Lake, Oregon	Mar. 26, 1956	One pink goose seen by Thomas Garrett, U. S. Fish and Wildlife Service
23	Burns, Oregon	Mar. 30, 1956	One pink goose seen by Mrs. Claude Brown. Reported by David B. Marshall, U. S. Fish and Wildlife Service
24	Malheur Lake, Burns, Oregon	April 11, 1956	One pink goose seen by David B. Marshall and Raymond M. Glahn, U. S. Fish and Wildlife Service
25	Burns, Oregon	April 11, 1956	Two pink geese seen by Rodney Canutt and James Yoakum, Oregon State College
26	Burns, Oregon	April 12, 1956	One pink goose seen by Jack Cory. Reported by W. C. Lightfoot, Oregon Game Commission
27	Burns, Oregon	April 12, 1956	Two pink geese seen by W. C. Lightfoot, Oregon Game Commission and William Hazeltine, U. S. Fish and Wildlife Service
28	Burns, Oregon	April 17, 1956	One pink goose seen in a flock of 500 geese by Henry Ausmus. Reported by W. C. Lightfoot, Oregon Game Commission
29	Flathead Lake, Montana	April 17, 1956	One pink goose seen in a flock of geese by local residents. Reported by Rudolph Grimm and Edmund Rogers, Nat. Park Service
30	Flathead Lake, Montana, near Big Fork	May 3, 1956	Five pink geese seen by local residents. Reported by George W. Mapes, U. S. Fish and Wildlife Service
31	Flathead Lake, Montana, near Ferndale	May 7, 1956	One pink goose seen in a flock of 25 geese by local residents. Reported by Sumner A. Dow, Montana Dept. of Fish and Game
32	Twelve miles west of Conrad, Montana	May 1, 1956	Three reports of pink and green geese (numbers not given) seen by local residents. Reported by Reuel G. Janson, Montana Dept. of Fish and Game
33	Valier, Montana	May 5, 1956	One pink goose seen in a flock of white geese by Aileen Offerdahl. Reported by Wynn Freeman, Montana Dept. of Fish and Game
34	Hussar, Alberta	April 18, 1956	Two pink geese seen in a flock of about 60 snow geese by a local resident. Reported by Fred Sharp, Ducks Unlimited (Canada)
35	Tyrell's Lake, New Dayton Alberta	April 18, 1956	Four pink geese seen by Andrew Sevidinski. Reported by G. Cooke, Lethbridge, Alberta

TABLE 3—Continued

Summary of Observations of the Geese Color-Marked at Tulelake, California—Spring, 1956

Map symbol	Where seen	Date seen	Reporter and remarks
36	Granum, Alberta	April 20, 1956	Number of pink geese seen in a flock of white geese by Harvey Dimm. Reported by W. W. Bell, Alberta Fish and Game Officer
37	Beaverhills Lake, Alberta	April 22, 1956	One pink goose seen in a large flock of snow geese by members of Edmonton Bird Club. Reported by Robert Lister, Univ. of Alberta
38	Cardston, Alberta	April 23, 1956	Two pink geese seen in a flock of about 250 snow geese by Eugene McCarty, Alberta Fish and Game Officer
39	Grand Prairie, Alberta	Last week of April, 1956	One pink goose seen in a flock of 15 snow geese by P. Sebastien. Reported by R. H. Mackay, Canadian Wildlife Service
40	Claresholm, Alberta	May 1, 1956	One pink goose seen in a flock of white geese by local residents. Reported by W. W. Bell, Alberta Fish and Game Officer
41	Didsburg, Alberta	May 1, 1956	Two pink geese seen by Mrs. K. Brown. Reported by Bernard Hamm, Canadian Wildlife Service
42	Thirty miles southwest of High River, Alberta	May 1, 1956	Two pink geese seen in a flock of 70 snow geese by H. E. F. AAstrup, Alberta Fish and Game Officer.
43	Lake McGregor, Alberta	May 3, 1956	Six pink geese seen in a flock of about 300 snow geese by H. E. F. AAstrup. Alberta Fish and Game Officer. Two reports of a yellow goose in this locality were also given to Mr. AAstrup
44	Namaka, Alberta	May 3, 1956	Five pink geese seen in a flock of about 300 snow geese, G. Freeman, Ducks Unlimited (Canada)
45	Lake McGregor, Alberta	May 4, 1956	Two pink geese seen in a flock of about 60 snow geese by H. E. F. AAstrup, Alberta Fish and Game Officer
46	Lake McGregor, Alberta	May 5, 1956	One pink goose seen in a small flock of snow geese by H. E. F. AAstrup, Alberta Fish and Game Officer
47	Edmonton, Alberta	May 6, 1956	Three pink geese with seven white geese seen by Mrs. Fulk. Reported by Robert Lister, Univ. of Alberta
48	St. Albert, Alberta	May 7, 1956	One pink goose seen in a flock of 200 snow geese by Mr. LaRue. Reported by H. R. Webster, Canadian Wildlife Service
49	Islay, Alberta	May 9, 1956	Nine green geese and one pink goose seen in a flock of about 900 snow geese by A. King. Reported by George Senz, Alberta Fish and Game Officer
50	Ta Ta Creek, British Columbia	May 9, 1956	One pink goose with 11 white geese. Reported by W. B. Wallator to Robert Lister, Univ. of Alberta
51	Bear Lake, Sexsmith, Alberta	May 10, 1956	One pink goose seen in a flock of about 20 snow geese by Bernard Hamm, Canadian Wildlife Service
52	Camrose, Alberta	May 11, 1956	Two pink geese seen by Bert D. Freeman, Alberta Fish and Game Officer
53	Verdigris Lake, Warner, Alberta	May 13, 1956	Three pink geese seen by G. Hortin Jensen, U. S. Fish and Wildlife Service

TABLE 3—Contined

Summary of Observations of the Geese Color-Marked at Tulelake, California—Spring, 1956

Map symbol	Where seen	Date seen	Reporter and remarks
54	Hay Lake, Alberta	May 15, 1956	One pink goose, band number 587-11063 shot by Slavey Treaty Indian. Reported by T. K. Thompson, Alberta Forest Officer to L. P. Gauthier, Alberta Forest Superintendent
55	Seba, Alberta	May 16, 1956	One pink goose seen in a flock of 60 geese by J. Greenwood. Reported by Don H. Dowler, Alberta Fish and Game Officer
56	Lac La Biche, Alberta	May 17, 1956	One pink goose seen in a flock of about 200 snow geese by O. A. Glimsdale, Alberta Fishery Officer
57	Valhalla Lake, Beaverlodge, Alberta	May 18, 1956	Three pink geese seen in a flock of about 100 snow geese by R. H. Mackay, Canadian Wildlife Service
58	Sexsmith, Alberta	June 1, 1956	One pink goose seen by Donald Fraser, Reported by John G. Stelfox, Alberta Game Biologist
59	Little Chicago, Northwest Territories	May 19, 1956	One pink goose seen by Isadore Cotchilly. Reported by W. E. Stevens, Canadian Wildlife Service
60	Aklavik, N. W. Territories	May 16, 1956	One pink goose seen by R. Andreason. Reported by J. E. Bryant and David A. Munro, Canadian Wildlife Service
61	Aklavik, N. W. Territories	May 22, 1956	One pink goose seen by J. W. Burton, Jr. Reported by J. E. Bryant and David A. Munro, Canadian Wildlife Service
62	Aklavik, N. W. Territories	May 24, 1956	One pink goose seen by C. Phillips. Reported by J. E. Bryant and David A. Munro, Canadian Wildlife Service
63	Mouth of Mackenzie River, N.W.T.	June 14, 1956	Four pink geese seen by Robert H. Smith, U. S. Fish and Wildlife Service, while flying waterfowl breeding grounds survey
64	Mouth of Anderson River, N.W.T.	June 14, 1956	One pink goose seen by Robert H. Smith, U. S. Fish and Wildlife Service, while flying waterfowl breeding grounds survey
65	Tuktoyaktuk, N.W.T.	June 3, 1956	Flock of about 30 pink geese seen by DEW Line Construction workers. Reported by W. E. Stevens, Canadian Wildlife Service

DISCUSSION

Tests showed that picric acid produced the most satisfactory color, as it faded less than others and was strikingly distinctive for field observations. Although the dyes used in this study are the best that have been tried to date, their qualities leave much to be desired. Further work with dyes, lacquers, and paints should be tried.

A few of the observations show that the colors were not reported accurately. Evidently, these reported changes in hues came about by the difference in color perception of the individual observer. Among the project personnel, it was noted that some individuals perceived the pink geese as the most intensely colored, while to others the yellow geese appeared to be the most strikingly colored. It is likely that a bird reported as a blue-colored goose was actually green, while a bird

reported as orange could be one of the pink geese. Furthermore, some of the Indians and Eskimos in the far north were so startled by the colored geese that they could easily have become confused over the actual colors.

Reports of the colored geese helped to fill in many of the gaps in our knowledge of the migration of these birds. Banding waterfowl does provide information pertaining to migration, but since the majority of the band returns are obtained during the hunting season, the data is most useful in showing the fall movements of the banded birds. On the other hand, by color-marking the white geese as they were leaving the wintering grounds, their spring migration could be traced by sight records as they moved from California to the breeding areas. The reports showed that some of the lesser snow geese took a northward route by way of western Oregon, along the Washington Coast, through British Columbia and into Alaska. Some probably went beyond the Bering Strait to nesting areas in Siberia. The remainder of the birds followed a route that passed through eastern Oregon, across Montana, through Alberta, and into the Northwest Territories reaching the breeding grounds of the Arctic Coast and Banks Island.

Finally, it should be pointed out that the success of a color-marking study of this nature depends on a well-organized system for obtaining and reporting the sight records of these birds. For this study it was relatively simple to use the co-operative efforts of the Pacific Flyway technical committee—an example of how dominion, provincial, federal and state technicians along the flyway work together.

SUMMARY

White geese (lesser snow geese and Ross' geese) were color-marked at Tulelake, California, during the spring of 1955 and 1956 to trace their spring migration. Sight records showed that after leaving Tulelake part of the lesser snow geese moved northward up the Pacific Coast to Alaska, while the remainder of the population went northward through eastern Oregon, Montana, Alberta and the Northwest Territories to the Canadian Arctic region.

During the fall of 1955 Ross' geese were colored at Tulelake to trace their movements on the wintering grounds. The sight records showed that these geese wintered throughout the Central Valley. None were reported from Imperial Valley.

The geese were colored by dipping their wings and tails in alcoholic dye solutions of Rhodamine B, malachite green and picric acid.

Since most returns from banded waterfowl are obtained during the hunting season, they are most useful for showing fall migrations. By color-marking geese, it was possible by sight records to trace their spring migration routes.

The success of a color-marking study depends on a well organized system of obtaining and reporting sight records. Such a system was easily organized through the Pacific Flyway Technical Committee.

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SOME PARASITES AND INFECTIOUS DISEASES IN A BLACK-TAILED JACKRABBIT POPULATION IN THE SACRAMENTO VALLEY, CALIFORNIA[1]

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INTRODUCTION

During a study of the general ecology of the black-tailed jackrabbit *(Lepus californicus)* in the Sacramento Valley, California, the opportunity arose to examine a sample of these hares for certain parasites and evidence of infectious disease. It is the purpose of this paper to present the results of these examinations with the hope that they may add to our general knowledge of the relation of these parasites and diseases to this animal.

A total of 485 jackrabbits was collected from the Gray Lodge State Waterfowl Management Area, Butte Co., California, during the period October, 1954, through March, 1956. Most of the jackrabbits were examined for their general physiological condition, the presence of any gross lesions, and conspicuous external or internal parasites. Beginning in April, 1955, a sample of blood was taken from some hares in the field immediately after they were shot. The sera from this blood was frozen and later tested for various antibodies. In addition to the jackrabbits in the kill sample, a number of them which had died of other causes were examined.

The Gray Lodge Waterfowl Management Area includes about 6,800 acres that are managed by the California Department of Fish and Game. About 2,000 acres are ponds and marshes and much of the remainder is planted to crops such as rice, millet, and barley. The surrounding farms are similar to the management area, but are less weedy and have a lower ratio of edge to fields, and fewer ponds and marshes. Most of the rain falls in the area from October through March. Winter temperatures occasionally go slightly below freezing, and summer temperatures often exceed 100 degrees F.

Jackrabbits are abundant and conspicuous members of the fauna of the area. During the study it was estimated that they were present at an average density of approximately one per acre of suitable habitat.

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Waterfowl Management Area contributed their time and facilities. Drs. A. S. Leopold, O. P. Pearson, W. C. Reeves, and R. D. Taber of the University of California, Berkeley, added many helpful suggestions. Dr. David Lackman of the Rocky Mountain Laboratory, Hamilton, Montana, conducted the serology of the jackrabbit blood. The fleas were identified by Dr. William L. Jellison, and the ticks by Mr. Glen M. Kohls of the same laboratory. Dr. D. P. Furman, of the Division of Entomology and Parasitology of the University of California at Berkeley, identified the bot flies. Dr. J. R. Douglas of the School of Veterinary Medicine of the University of California at Davis identified the round worms. Dr. Marietta Voge of the Department of Infections Diseases of the University of California at Los Angeles identified the tapeworms. Dr. Norman D. Levine of the College of Veterinary Medicine at the University of Illinois confirmed that the intestinal lesions were those of coccidiosis. To all of these and to others who aided in any way, I extend my sincere thanks.

RESULTS AND DISCUSSION

Parasites

Fleas

Fleas were found on the hares during every month of the year, but were never abundant. They could not be found on some hares and varied from a few to perhaps 50 on others. With the single exception of an unidentified rodent flea, all were *Holopsyllus foxi*, the common rabbit flea of California. This species of flea is more or less confined to hares and rabbits, and there is no evidence of its occurrence on man, nor of its transmission of either plague or tularemia, both of which are found within its range (Hubbard, 1943).

Ticks

Ticks occurred on the hares in all months. Nymphs were present at all times, but adults were found only from March through August and larvae from August through November. Although engorged ticks were found any place on the body, the majority were attached on the head and ears. During March, April, and May it was common to find as many as 20 of them on the ears.

All ticks were the common rabbit tick *Haemaphysalis leporis-palustris*. This tick is widely distributed throughout the country and parasitizes a variety of mammals and birds (Green, Evans, and Larson, 1943). There is only one report of this species parasitizing man (Brown, 1945). This tick is undoubtedly a factor in the spread of infection from hares to other animals and vice versa, but its greatest importance might be in the spread of infection from hare to hare.

Lice

No searches were made for lice, but three were found in the collection bags with the fleas and ticks. One of these was identified as a rabbit louse *Haemodipsus* sp.

Warbles

Warbles are caused by the larvae of the bot fly (*Cuterebra* spp.) which live in cysts in the subcutaneous tissues. Warbles, or bots as they are called, are often very abundant on jackrabbits. Vorhies and Taylor (1933) report 50 percent of the Arizona jackrabbits examined by them were infected with bots; Philip, Bell, and Larson (1955) report many cases of jackrabbits with multiple infestations on certain Nevada ranches during a jackrabbit die-off in 1952.

In the present study only three jackrabbits were found to be infected by bots, two in July and one in September. The bots were located on the rump area; one hare had one while the others had two. It was determined that these were larvae of *Cuterebra*, but since no adults were available, species identification was impossible. It appears that these parasites were a negligible factor affecting the Gray Lodge jackrabbit population during the study period.

Round Worms

Small, red, round worms were numerous in the stomachs of the majority of the hares examined. At least two species were present. One species was identified as *Biogastranema affinis*, but the other was not identified. These worms did not appear to cause any extensive damage to the stomach wall.

Tapeworms

Adult tapeworms, ranging from one to many per individual were found in the small intestines of over one-third of the hares examined. No seasonal incidence of occurrence could be detected. One animal which weighed less than 1,000 grams had many of the worms in its small intestine.

These tapeworms were identified as *Cittotaenia pectinata* and *Raillietina (Paroniella) retractulus*. The former were much more common than the latter. Severaid (1942) reports the former species in the snowshoe hare. Vorhies and Taylor (1933) report only a single record of a mature tapeworm in the jackrabbits of the Santa Rita Range of Arizona.

The most conspicuous of the parasites found were the larval forms of the tapeworms *Taenia* sp. and *Multiceps* sp. which encyst in the mesenteries and in the connective tissue between the muscle masses. The cysts, which are watery and contain numerous small white cysticerci, are commonly referred to as water boils, and cause distinct swellings which vary from one-quarter to four inches in diameter.

Fifty-eight of the 347 hares (17 percent) examined had one or more of these cysts. Many of these were single occurrences, but several animals had as many as five cysts. The average number of cysts per infected hare was 1.39. There was no seasonal periodicity or difference between the sexes as regards incidence of infection. Older animals were more completely infected than were the young.

The majority of the infections were those of *Multiceps* sp. and most were located in the skeletal muscles. Table 1 shows the location of the 81 cysts found. There appears to be a tendency for the cysticerci to locate in the heavy muscle masses of the back, thigh and shoulder.

TABLE 1

Location of 81 Larval Tapeworm Cysts on 58 Jackrabbits

Area	Number of cysts	Percent
Back	33	40.7
Thigh	21	25.9
Shoulder	11	13.5
Jaw	6	7.4
Ribs	3	3.7
Forearm	2	2.4
Neck	1	1.3
Eye	1	1.3
Heart	1	1.3
Abdomen	1	1.3
Tail	1	1.3

Although some of the jackrabbits were heavily parasitized, and some of the "boils" were as large as four inches in diameter, none of the hares seemed hampered by their presence. One had its left eye closed by the swelling, and another had a cyst on the left ventricle of the heart which was as large as the ventricle itself, yet these individuals seemed to be as lively as any other hares. Observations were made on several hares which had swellings almost the size of oranges on the rump or shoulder and still they seemed as active as the others. Perhaps such parasitism weakens the animals and makes them more susceptible to predation, but this cannot be verified from the present study.

Although the cysts are unsightly they do not alter the edibility of the meat. The presence of the cysts is no reason for discarding the jackrabbit. The infected part can be removed and the remainder of the hare should be thoroughly cooked before it is eaten to kill any larvae which might remain.

Flukes

The jackrabbit has been implicated as a reservoir of the common liver fluke *Fasciola hepatica* in Texas by Olsen (1948). During the present study, livers of over 300 jackrabbits were sliced and examined but no flukes were found and no case of hypertrophy or malformation of the gall bladder or common bile duct was noted. Many of the jackrabbits in this sample were collected from sheep pastures surrounding the management area, but it is not known whether the sheep were infected with flukes.

Coccidia

Coccidia are a common infection in rabbits and hares. Becker (1934) lists six species of the genus *Eimeria*. Herman and Jankeiwicz (1943) report 98 percent incidence of the genus in the feces of cottontails on the San Joaquin Experimental Range. Bull (1953) reports 99 percent incidence in European wild rabbits in New Zealand, and suggests that *Eimeria stiedae* may be a significant agent in the mortality of young rabbits.

The examination of the caecal contents of the jackrabbits collected in every month of the year from Gray Lodge reveals over 90 percent incidence of coccidian oocysts. No attempt was made to identify these species, but since they varied in size and form, and since no other genus

has been recorded from rabbits and hares, they probably represent various species of *Eimeria*.

Although almost every jackrabbit had oocysts present in its caecal contents, no case of gross lesions of the liver or intestines was noted in the kill sample. During the winter of 1955-56 much of the study area was flooded by heavy rains. At this time the jackrabbits were forced out of the fields and onto the roads and levees where survival was difficult. During this period many jackrabbits that died had multiple, pinhead size, white lesions in the small intestines. Histological sections of these intestines showed numerous stages of coccidia of the genus *Eimeria*.

It appears that only during this flood period when the hares were crowded into, wet, unsuitable environments did these parasites exert their influence. At this time the hares were undoubtedly in a weakened condition, and contacts between individuals probably increased, favoring a constant reinfection with oocysts. Then the coccidia became a major factor affecting the mortality of the jackrabbits. What role they may play in more normal times is not clear, but from the hares examined in this study it appears to be slight.

Viral, Rickettsial and Bacterial Diseases

Blood samples from the 142 jackrabbits collected throughout the year were examined serologically for antibodies of Rocky Mountain spotted fever, Q fever, ornithosis, typhus, western equine encephalitis, tularemia and brucellosis. Complement-fixation tests of rabbit sera are difficult to interpret (DeBoer and Cox, 1947) and in Table 2 only those titers which showed some specific indication of antibody on repeat testing are listed as positive.

TABLE 2

Complement-fixing Antibodies in Jackrabbit Sera

Month	Number of samples	Rocky Mountain spotted fever	Titer	Q Fever	Titer	Western equine encephalitis	Titer
1955							
April	26	5	all 1:64	0		0	
May	19	1	1:16	0		1	1:8
June	20	0		0		0	
July	14	0		0		0	
August	8	0		0		1	1:16
September	10	1	1:32	1	1:32	3	1:64 1:32 1:16
October	8	0		1	1:32	0	
November	8	0		0		1	1:16
1956							
January	9	0		1	1:32	1	1:32
February	10	0		1	1:32	1	1:16
March	10	3	1:256 1:64 1:192	1	1:32	0	
Total	142	10		5		8	

Rocky Mountain Spotted Fever

Specific indication of complement-fixing antibodies for Rocky Mountain spotted fever were present in 10 of the 142 sera tested. Philip, Bell and Larson (1955) found that 35 of 260 sera from nothern Nevada jackrabbits showed such a complement-fixing response. Eight of their positives were subjected to toxin neutralization tests and four gave positive results while the other four gave no neutralization. Thus, one cannot state that Rocky Mountain spotted fever definitely is present in the Gray Lodge jackrabbits. The conclusive proof would be the isolation of the organism. The seasonal incidence of the positives shown in Table 2 is interesting since they all occurred at times of the year when fully engorged ticks were present in great numbers on the hares. In any case, there appears little danger of spread of this infection from the hares to humans since, as shown earlier, the ticks present on the jackrabbits do not ordinarily parasitize man. However, the presence of spotted fever in the area is indicated and man could become infected from some other source.

Q Fever

This disease is reported to be endemic in the general area surrounding the Gray Lodge Waterfowl Management Area (Clark, Lennette, and Romer, 1951) and it is not surprising that antibodies against it were found in some of the jackrabbit sera. Many of the sera were taken from hares collected in areas where sheep graze, and sheep are known to be susceptible to infection with this organism.

Ornithosis and Typhus

All sera were negative for both of these agents.

Western Equine Encephalitis (WEE)

The number of positive results for this agent must be rather carefully interpreted since complement-fixing antibodies against WEE virus are evanescent, building up and disappearing rapidly. Philip, Bell, and Larson (1955) state, "Serological studies on sera from hares have shown that complement-fixation and mouse-neutralization tests for the presence of WEE and spotted fever antibodies are not in complete agreement, though there is good correlation." The low number of hares showing positive results in the present study may be temporal due to the short period of time one can detect complement-fixing antibodies as compared to neutralizing antibodies.

Table 3 compares the findings of this study with those of other studies involving the black-tailed jackrabbit and WEE. It can be seen that the percentage of positives in this study is lower than the majority of the others; however, none of these were dealing with many specimens with the exception of Philip, Bell, and Larson (1955). The higher incidence in the latter study can probably be attributed to the expected differences between the two types of tests plus the fact that 16 of the positives in their study were from hares taken on a ranch where sick horses and one case of human encephalitis had been reported earlier.

TABLE 3

Results of Surveys of Black-tailed Jackrabbit Sera for Western Equine Encephalitis Antibodies

Reference	Area	Number of sera tested	Number positive	Type of test
Philip, Bell and Larson (1955)	Northern Nevada	275	38 (14 percent)	Neutralization
Reeves, Mack and Hammon (1944)	Oklahoma	12	0 (0 percent)	Neutralization
Hammon, Lundy, Gray, Evans, Bank and Izumi (1942)	Yakima Valley, Washington	12	2 (16 percent)	Neutralization
Hammon and Reeves (1944)	Kern County, California	5	1 (20 percent)	Neutralization
Hutson, Howitt and Cockburn (1950)	Weld County, Colorado	25	2 (8 percent)	Neutralization
Present Study	Butte County, California	142	8 (6 percent)	Complement-fixation

Brucellosis

Jacatot, Vallee, and Barriere (1951) report wild hares in France with brucellosis. Philip, Bell, and Larson (1955) found sera from three jackrabbits in Nevada which agglutinated *Brucella abortus* antigen in titers of 1:80. These same sera were negative for *Bacterium tularense* antibodies. Thus it appears that hares might be implicated as possible reservoirs of this disease. In the present study no agglutinating antibodies against *Brucella abortus* were found. It is not known if the disease is present in cattle herds which are pastured on fields surrounding the study area, but from the data in this study the jackrabbits cannot be implicated as reservoirs or carriers of this disease in this area.

Tularemia

None of the sera showed agglutinating antibodies against *Bacterium tularense*. This is not surprising since such antibodies have never been shown in the sera of wild rabbits. Philip, Bell, and Larson (1955) report that four captive Kansas jackrabbits injected with 10^6 or more organisms of a proven virulent strain of *B. tularense* died. Only one developed an agglutination titer (1:40) before death, six days after injection. Two other injected with only 10^2 organisms each did not become ill and did not develop antibodies after 34 days. It appears that this same thing may occur in the wild, and any jackrabbit which develops the disease dies, therefore no survivors show antibodies against the organism. This has been the explanation of the findings with the cottontail rabbit, for they too apparently do not possess antibodies in the wild (Bell and Chalgren, 1943). MacLulich (1937) and Green, Larson, and Bell (1939) have demonstrated agglutinating antibodies against *B. tularense* in sera from wild snowshoe hares, indicating that this species is more resistant and that some animals recover.

During the present study eight jackrabbit carcasses were found that had small, round, white lesions on the liver and spleen. Three of these were found in December, 1954, three in February, 1955, one in January, 1956, and one in February, 1956. No bacterial isolations were made from any of these animals, but pieces of the livers of some of them were

preserved in formalin and later sectioned and stained. They showed necrotic lesions with some cellular infiltration and could have been caused by an infection with tularemia. However, positive diagnosis cannot be made on this basis. Although these could have been cases of the disease, the time of occurrence seems strange, for all occurred during a low point in the abundance of known vectors such as ticks and flies. It could be that because of the low incidence of vectors the disease was confined to a few hares and did not reach epidemic proportions. Occurrences of tularemia in rabbits and hares are known to be sporadic and it has been demonstrated that arthropods such as ticks serve as reservoirs as well as vectors. There is a constant possibility that tularemia may flare into epidemic proportions at any time in jackrabbits when the vectors become abundant. Therefore, the public should be informed of this danger and of preventive measures against the disease.

SUMMARY

A sample of black-tailed jackrabbits collected over an 18-month period from the Gray Lodge State Waterfowl Management Area, Butte Co., California, was examined for certain parasites and antibodies against infectious diseases.

Fleas *(Holopsyllus foxi)*, ticks *(Haemaphysalis leporis-palustris)*, lice *(Haemodipsus* sp.), bots *(Cuterebra* sp.), round worms *(Biogastrancma affiins)*, adult tapeworms *(Cittotaenia pectinata, Raillietina retractilus)*, larval tapeworms *(Taenia* sp., *Multiceps* sp.), and coccidia *(Eimeria* spp.) are present as parasites.

There are specific indications of complement-fixing antibodies for rocky mountain spotted fever, Q fever and western equine encephalitis present in the blood of the jackrabbits.

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CALIFORNIA INLAND ANGLING ESTIMATES FOR 1954, 1956, AND 1957[1]

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This report, covering the years 1954, 1956, and 1957, is the latest in a series on California angling catch estimates initiated in 1935. Previous surveys of this type have been described by Calhoun (1950, 1951, 1953), Clark (1953), Curtis (1939), and Skinner (1955).

These surveys indicate statewide trends in angling pressures, sport fish catches, and effects of management practices designed to regulate them. The surveys provide the most reliable information available on trends in the important striped bass fishery. Although actual numbers instead of index numbers are used, it is emphasized that these numbers only show trends and may grossly exaggerate the true catch figures.

Prior to 1940, catch and angler estimates were derived from information voluntarily supplied by license buyers at time of license purchase. This procedure proved unsatisfactory, because it was expensive, complicated, and delayed obtaining information from anglers (Hunter and Fry, 1940).

Direct sampling of all licensees with postal card questionnaires was initiated by Curtis (1939). Speed, ease of processing, and successful use of a smaller sample size contributed to early acceptance of the system. Certain inherent deficiencies due to space limitations on the cards were apparent, but these proved practically impossible to eliminate. Results were in terms of successful anglers only, since numbers of anglers who fished unsuccessfully for each species could not be determined. Anglers who did not buy licenses were likewise excluded. Curtis estimated that if unlicensed juveniles were included in these surveys, total catch estimates might be increased by 25 percent.

Efforts subsequently have been made to include unsuccessful anglers through use of detailed questionnaires. However, dissatisfaction with the detailed questionnaires, as such, resulted in a lack of confidence in estimates of unsuccessful anglers.

The present report is based on successful anglers only, and does not include unlicensed anglers.

METHODS

A stratified random sample[2] of all angling license buyers was selected each year, representing about 0.7 percent of all licensees. The actual percentage varied slightly from year to year, as shown in Table 1.

[1] Submitted for publication November, 1958.

[2] Licensees were sampled by selecting names from each license stub book or group of books according to a prearranged plan; e.g., the fifth name in each fourth book of 25 names.

License buyers included in the sample were mailed printed postal card questionnaires, as shown in Figure 1. In 1954, letter questionnaires requiring more detailed answers also were used. These subsequently proved unsatisfactory and only postal card data were used.

It is assumed that the anglers who returned the postal card questionnaires are representative of California anglers as a whole. Therefore, the statewide estimates are merely the projection of postal card reports according to the ratio obtained by dividing the number of reports received into the total number of licensed anglers.

Will You Help Improve Fishing in California?

In order to find out whether our efforts to provide better fishing are bringing results we need to know how many fish are caught each year in California. No one can tell us this as well as the fisherman.

We are therefore asking a selected number of California anglers to tell us what they catch. You have been chosen to take part in this test. Will you help? All we ask you to do is to:

PLEASE WRITE ON THE RETURN CARD your best estimate of the number of each kind of fish you caught last year and the counties where you caught them. Also please give us your best estimates in answer to questions about number of days fished.

IF YOU CAUGHT NO FISH OF ANY KIND, PLEASE SAY SO.

You do not need to sign the card; this is not a personal check-up. But please do send us the record of your catch, and thus do your bit for better fishing.

CALIFORNIA DEPARTMENT OF FISH AND GAME

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PLEASE HELP THE CALIFORNIA DEPARTMENT OF FISH AND GAME IN ITS EFFORTS TO IMPROVE FISHING BY FILLING OUT AND MAILING THIS CARD

Did you catch any fish in 1957? (Please answer Yes or No) . . . . . ———

How many days did you go fishing in 1957? . . . . . ———
(If you do not know exactly, give your best estimate)

Please list below the number of each kind of fish you caught, the counties where you caught them, and the number of days you fished for each kind

SPECIES	COUNTY OF CATCH	NUMBER	COUNTY OF CATCH	NUMBER	COUNTY OF CATCH	NUMBER	TOTAL DAYS OF FISHING, EACH SPECIES
STRIPED BASS							
ALL TROUT INCLUDING YOUNG STEELHEAD							
STEELHEAD OVER 1 POUND							
SALMON— IN RIVERS							
SALMON— IN OCEAN							
BLACK BASS (FRESHWATER)							
CATFISH							
FRESHWATER PANFISH (BLUEGILL, CRAPPIE, ETC.)							
OCEAN FISH							

FIGURE 1. Postal card questionnaire used in 1954, 1956, and 1957.

TABLE 1

Basic Characteristics of the Three Surveys

	1954		1956		1957	
	Number	Percentage	Number	Percentage	Number	Percentage
Angling licenses sold	1,240,043	--	1,380,787	--	1,433,630	--
Questionnaires sent	4,461	0.4	9,754	0.7	9,547	0.7
Questionnaires returned	1,598	35.0	3,542	36.3	3,055	32.0
Usable returns	1,559	97.6	3,520	99.4	3,041	99.6
Respondents did not fish	66	4.2	137	3.9	132	4.3
Unsuccessful respondents	112	7.2	553	15.6	611	20.0
Successful respondents	1,447	92.8	2,830	80.4	2,298	75.6
Projection factor*	795.41	--	392.27	--	471.43	--
Mean days fished	15	--	14	--	15	--

* Total angling license sales ÷ usable returned questionnaires.

About three times as many questionnaires were sent as were actually required, since only about 30 percent of the questionnaires normally were completed and returned. Calhoun (1950) investigated the problem of nonresponse and concluded it did not greatly distort the results.

RESULTS

Since these surveys are in a series, they follow the same form for the sake of continuity.

Certain species are grouped on the questionnaire to reduce angler confusion. No attempt is made to separate the various species of salmon and trout, or other groups of fish, since many anglers do not recognize specific differences.

Sunfish and crappie were treated separately prior to 1954, but from 1954 on they are combined as panfish. Similarly, kokanee salmon are included with trout.

Striped bass and salmon are included in the survey, although many are caught in the ocean.

Trout

Trout fishing is by far the most popular form of angling in California. Throughout the surveys, about half of all licensed anglers fished for them each year. In these surveys, days fished for trout varied from 41.4 to 46.1 percent of total days spent for all inland species.

The catch trend is definitely upward. Table 2 shows that the greatest catch recorded was in 1957. Although both total catch and anglers have increased nearly every year, the median annual catch per successful angler has not changed significantly. This stabilization of the average catch may reflect the support provided by the extensive catchable trout planting program. Approximately 8,000,000 catchable trout are released in roadside waters each year.

Trends in the trout catch are shown in Tables 1A and 7A through 13A in the appendix.

TABLE 2

Sumary of Trout Catch Characteristics

	1954	1956	1957
Total catch	28,600,000	26,200,000	30,660,000
Total successful anglers	578,000	640,000	718,000
Total days fished	5,962,000	5,638,000	6,318,000
Mean annual catch	49.5	40.8	42.7
Median annual catch	22	21	21
Mean annual days fished	10	9	9
Median annual days fished	7	6	6
Mean catch per angler day	5.0	4.7	4.6
Percentage of total licensed inland anglers, including ocean salmon anglers	46.6	46.5	50.1
Percentage of total days fished for all inland species	46.1	43.2	41.4

Striped Bass

Total catch during these surveys varied from 1,000,000 in 1956 to 1,890,000 in 1957, as shown in Table 3. Numbers of successful anglers varied from 127,000 to 230,000 over the same period. Table 2A shows that the long-term trend in catches has been down. Although the 1957 catch represented the best yield since 1941, the 1956 catch, by contrast, was the poorest ever recorded.

TABLE 3

Summary of Striped Bass Catch Characteristics

	1954	1956	1957
Total catch	1,440,000	1,000,000	1,890,000
Total successful anglers	158,300	127,000	230,000
Total days fished	1,683,000	1,565,000	2,616,000
Mean annual catch	9.3	7.9	8.2
Median annual catch	5	5	5
Mean annual days fished	8.8	10.0	10.1
Median annual days fished	6	6	6
Mean catch per angler day	0.9	0.6	0.7
Percentage of total licensed inland anglers, including ocean salmon anglers	12.8	9.2	16.0
Percentage of total days fished for all inland species	13.0	12.0	17.2

Several factors are involved in these recent abrupt changes. In 1956, the minimum size limit was increased from 12 to 16 inches. About 40 percent of the catch had been bass under 16 inches, so the sharp decline in 1956 was expected (California Department of Fish and Game, 1957). The 1957 catch was undoubtedly reinforced by sizeable numbers of fish between 12 and 16 inches which escaped capture in 1956. Another contributing factor was the unusually strong 1953 and 1954 year classes, which first entered the catch in 1957. The improvement in fishing was apparent immediately, and this stimulated much greater angler efforts. These factors combined to produce a modern catch record.

Detailed characteristics of the striped bass catch are shown in Tables 7A through 13A in the appendix.

Ocean Salmon

Salmon fishing in the ocean showed a steadily increasing effort and total catch through 1954. Since then, the catch has declined slightly each year, while angling pressure has continued to mount. The mean annual catch per angler has decreased accordingly, but the median has remained stable at four fish.

The apparent decrease in total catch, despite increased angler effort, reflects the general statewide decline in salmon stocks. If it were not for increased angling pressure, the catch would probably have been much lower.

Table 4 and appendix Tables 7A through 12A show detailed characteristics of the ocean salmon catch during the survey period.

Table 3A in the appendix shows trends in catches, successful anglers, and other information on combined ocean and river salmon angling.

River Salmon

Table 5 indicates that the catch of river salmon has remained relatively constant during the three years surveyed. Numbers of anglers likewise remained relatively stable. Days fished showed an increase from 1954 to 1956, but declined slightly in 1957. Despite the early increase in days fished, the median annual catch changed little from year to year. The catch per angler day has shown a steady decline.

TABLE 4

Summary of Ocean Salmon Catch Characteristics

	1954	1956	1957
Total catch	660,000	500,000	480,000
Total successful anglers	92,300	99,600	101,000
Total days fished	457,000	494,000	549,000
Mean annual catch	7.4	5.0	4.8
Median annual catch	3	4	4
Mean annual days fished	5.2	4.9	4.5
Median annual days fished	3	4	3
Mean catch per angler day	1.4	1.0	0.9
Percentage of total licensed inland anglers, including ocean salmon anglers	7.4	7.2	7.0
Percentage of total days fished for all inland species	3.5	3.8	3.6

TABLE 5

Summary of River Salmon Catch Characteristics

	1954	1956	1957
Total catch	200,000	220,000	215,000
Total successful anglers	49,300	40,800	46,200
Total days fished	302,000	433,000	426,000
Mean annual catch	4.6	5.3	4.7
Median annual catch	3	4	3
Mean annual days fished	5.5	8.4	6.6
Median annual days fished	3	5	4
Mean catch per angler day	0.8	0.6	0.5
Percentage of total licensed inland anglers, including ocean salmon anglers	4.0	3.0	3.2
Percentage of total days fished for all inland species	2.3	3.3	2.8

Tables 7A through 12A in the appendix show detailed characteristics of the river salmon sport fishery.

Table 3A in the appendix shows trends in catches, successful anglers, and other information on combined ocean and river salmon angling.

Steelhead

Steelhead anglers, on the average, catch less than one fish per angler day. Table 6 shows a highly significant increase in catch, successful anglers, and days fished in 1957. Median catches, as well as other catch characteristics, show little change during the years surveyed.

The tendency of anglers to list large, silvery resident trout as steelhead in some areas may in part account for the 1957 increase. There is no other apparent reason, and it may be due to sampling error.

Tables 4A and 7A through 13A in the appendix show catch characteristics in detail.

TABLE 6

Summary of Steelhead Catch Characteristics

	1954	1956	1957
Total catch	340,000	360,000	600,000
Total successful anglers	56,500	59,600	85,300
Total days fished	444,000	580,000	746,000
Mean annual catch	6.2	6.0	7.0
Median annual catch	3	3	4
Mean annual days fished	6.5	8.0	7.4
Median annual days fished	4	5	5
Mean catch per angler day	1.0	0.8	0.9
Percentage of total licensed inland anglers, including ocean salmon anglers	1.6	4.3	6.0
Percentage of total days fished for all inland species	3.4	4.4	4.9

Black Bass

Black bass are popular in California. They promise to become increasingly important in the future, as more large artificial lakes are created under the California Water Plan.

Table 7 shows little change in catch characteristics during this survey period, but Table 5A shows a long-term trend upward in both total catch and total anglers. Other characteristics of the catch are shown in Tables 7A through 13A in the appendix.

Catfish

Catfish annually rank about third behind trout and panfish in numbers caught. The number of anglers who catch catfish rank second only to those who catch trout.

White catfish, brown bullheads, and channel catfish are the most important species, in that order. They account for over 90 percent of the total caught.

Table 8 indicates a relatively stable annual catch in recent years. Table 6A shows a long-term trend toward more successful anglers each year and a corresponding drop in the mean catch. Most of the other catch characteristics show little change. Tables 7A through 13A in the appendix present detailed information on the surveys by years.

Panfish

This category embraces all sunfishes and crappies. Prior to 1954, these two groups were categorized separately.

Table 9 indicates an apparent decrease in total catch, although successful anglers and days fished exhibit little change.

Tables 7A through 13A in the appendix show detailed information on the catch characteristics and effort expended.

TABLE 7

Summary of Black Bass Catch Characteristics

	1954	1956	1957
Total catch	2,300,000	2,550,000	2,440,000
Total successful anglers	153,500	164,000	179,000
Total days fished	1,093,000	1,096,000	1,358,000
Mean annual catch	15.1	15.6	13.6
Median annual catch	8	9	8
Mean annual days fished	6.9	7.0	7.6
Median annual days fished	4	4	5
Mean catch per angler day	2.2	2.2	1.7
Percentage of total licensed inland anglers, including ocean salmon anglers	12.4	11.9	12.5
Percentage of total days fished for all inland species	8.5	8.4	8.9

TABLE 8

Summary of Catfish Catch Characteristics

	1954	1956	1957
Total catch	7,990,000	6,970,000	7,370,000
Total successful anglers	219,500	216,500	259,000
Total days fished	1,568,000	1,594,000	1,920,000
Mean annual catch	36.5	32.2	28.4
Median annual catch	13	10	13
Mean annual days fished	7.7	8.1	8.4
Median annual days fished	4	5	5
Mean catch per angler day	4.7	3.9	3.3
Percentage of total licensed inland anglers, including ocean salmon anglers	17.7	15.7	18.1
Percentage of total days fished for all inland species	12.1	12.2	12.6

TABLE 9

Summary of Panfish Catch Characteristics

	1954	1956	1957
Total catch	10,970,000	10,020,000	7,680,000
Total successful anglers	205,200	225,000	244,000
Total days fished	1,415,000	1,641,000	1,318,000
Mean annual catch	53.4	44.5	31.4
Median annual catch	26	18	17
Mean annual days fished	5.0	7.6	6.4
Median annual days fished	4	5	5
Mean catch per angler day	7.8	6.1	5.8
Percentage of total licensed inland anglers, including ocean salmon anglers	16.6	15.7	17.0
Percentage of total days fished for all inland species	10.9	12.6	8.6

REGIONAL CATCHES

Catches have been grouped by areas fished, to reveal the relative importance of the department's five administrative regions. Figure 2 shows the regional boundaries.

Since some anglers do not report catch locations, statewide catches are larger than combined regional catches. Catches from unknown locations appear in statewide totals, but do not appear in regional totals.

Estimates for 1953 are provided for comparative purposes from Skinner (1955).

Region 1

Region 1 includes the northernmost California counties. It is characterized by a vast number of fishable waters and the smallest human population in the regional group. All the important species, except striped bass, are taken there in large numbers. Table 10 shows the

FIGURE 2. Department of Fish and Game administrative regions.

total catch and the percentage of each species in relation to state totals during the survey period.

Region 2

Region 2 includes the northern Sierra, northern Central Valley, and the Sacramento-San Joaquin Delta. With this diverse area, it provides fishing for all important species. Catfish and striped bass are the two most important species, although steelhead, trout, and river salmon also rank high. Table 11 shows the regional catch and its percentage of the state totals.

Region 3

Region 3 covers the central coastal counties in a 400-mile belt. It is the most important area of the State for striped bass and ocean salmon. Steelhead, black bass, panfish, and catfish also are caught in important numbers. Table 12 shows the species catch in Region 3 during the survey period.

Region 4

Region 4 covers the central California counties. It approximates Region 2 in angling diversity. The trout catch in this region is second only to Region 5. Warmwater fish are also very important. Table 13 shows the relative importance of Region 4 in comparison with the other regions.

Region 5

Region 5 embraces Southern California, plus Inyo and Mono Counties. It is an area of relatively restricted fish habitat combined with a dense human population. The fish catch reflects the heavy recreational demands imposed by the people of this region. The trout catch has been the largest of any region for a number of years. No striped bass are available, and only a few salmon and steelhead are taken in the extreme northern coastal part of the region. Large numbers of black bass, panfish, and catfish help compensate for the lack of other species important farther north, but the overall trend in warmwater fish catches in this region is down.

Table 14 shows the catch in Region 5 during this survey.

TABLE 10

Catch in Region 1

Species	1953		1954		1956		1957	
	Total	Percentage of State total	Total	Percentage of State total	Total	Percentage of State total	Total	Percentage of State total
Trout	3,700,000	17.8	6,400,000	24.0	3,830,000	14.3	3,270,000	10.4
Ocean salmon	106,000	25.5	79,000	12.0	6,000	1.4	108,000	22.8
River salmon	115,000	56.9	143,000	71.1	150,000	71.0	129,000	64.8
Steelhead	200,000	75.8	228,000	55.7	196,000	54.4	267,000	49.7
Black bass	120,000	5.7	81,000	3.5	171,000	6.7	241,000	10.1
Catfish	165,000	2.7	216,000	3.3	283,000	4.3	248,000	3.0
Panfish	--	--	465,000	4.2	339,000	3.2	446,000	5.5
Striped bass	--	--	--	--	--	--	--	--

TABLE 11

Catch in Region 2

Species	1953 Total	1953 Percentage of State total	1954 Total	1954 Percentage of State total	1956 Total	1956 Percentage of State total	1957 Total	1957 Percentage of State total
Trout	5,100,000	24.4	6,436,000	24.1	5,935,000	22.2	8,095,000	25.9
Ocean salmon	--	--	--	--	--	--	--	--
River salmon	68,000	33.7	39,000	19.4	37,000	17.7	33,000	16.3
Steelhead	27,000	10.2	88,000	21.5	65,000	18.1	153,000	28.6
Black bass	310,000	14.0	299,000	12.8	797,000	31.0	732,000	30.6
Catfish	3,100,000	49.7	2,821,000	42.6	3,091,000	46.6	3,485,000	41.9
Panfish	--	--	634,000	5.8	339,000	3.2	1,306,000	16.2
Striped bass	600,000	44.5	573,000	42.9	415,000	47.4	679,000	37.6

TABLE 12

Catch in Region 3

Species	1953 Total	1953 Percentage of State total	1954 Total	1954 Percentage of State total	1956 Total	1956 Percentage of State total	1957 Total	1957 Percentage of State total
Trout	1,840,000	8.8	993,000	3.7	1,983,000	7.4	4,562,000	14.6
Ocean salmon	310,000	74.5	572,000	87.1	384,000	91.1	344,000	72.2
River salmon	15,000	7.4	14,000	7.0	18,000	8.7	25,000	12.8
Steelhead	34,000	12.9	75,000	18.3	64,000	17.8	110,000	20.5
Black bass	540,000	24.6	486,000	20.8	326,000	12.7	681,000	28.5
Catfish	920,000	14.9	1,713,000	25.9	1,511,000	22.8	3,020,000	36.3
Panfish	--	--	1,648,000	15.0	2,319,000	22.2	2,768,000	34.1
Striped bass	730,000	54.5	747,000	65.9	406,000	46.5	1,087,000	60.1

TABLE 13

Catch in Region 4

Species	1953 Total	1953 Percentage of State total	1954 Total	1954 Percentage of State total	1956 Total	1956 Percentage of State total	1957 Total	1957 Percentage of State total
Trout	3,270,000	15.7	4,963,000	18.6	4,282,000	16.0	6,294,000	20.1
Ocean salmon	--	--	--	--	--	--	--	--
River salmon	4,000	2.0	5,000	2.5	2,000	1.1	9,000	4.7
Steelhead	2,000	0.7	2,000	0.5	24,000	6.5	1,000	0.3
Black bass	350,000	15.7	462,000	19.8	650,000	25.2	441,000	18.4
Catfish	790,000	12.8	604,000	9.1	997,000	15.0	1,026,000	12.3
Panfish	310,000	9.4	1,257,000	11.5	687,000	6.6	1,720,000	21.4
Striped bass	13,000	1.0	15,000	1.1	29,000	3.3	28,000	1.5

TABLE 14

Catch in Region 5

Species	1953		1954		1956		1957	
	Total	Percentage of State total	Total	Percentage of State total	Total	Percentage of State total	Total	Percentage of State total
Trout	6,950,000	33.4	7,910,000	29.6	10,598,000	39.7	8,726,000	27.9
Ocean salmon	--	--	6,000	0.9	2,000	0.4	--	--
River salmon	--	--	--	--	--	--	--	--
Steelhead	--	--	16,000	3.9	6,000	1.7	--	--
Black bass	880,000	40.0	1,007,000	43.1	604,000	23.5	280,000	11.7
Catfish	1,230,000	19.9	1,262,000	19.1	644,000	9.7	466,000	5.6
Panfish	--	--	6,956,000	63.5	5,371,000	51.3	1,700,000	21.1
Striped bass	--	--	--	--	--	--	--	--

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John Skinner planned and carried out the 1954 survey.

John Mahoney planned and partially completed the 1956 and 1957 surveys.

SUMMARY

Postal card and/or letter-type questionnaires were sent to a stratified random sample of California angling license holders to determine catch trends and angler days expended in 1954, 1956, and 1957. About 30 percent of the questionnaires were returned each year.

Tabulation of returned questionnaires revealed trout to be consistently the most important fish in both number caught and in days expended to catch them. Others, by decreasing numbers caught, were panfish, catfish, black bass, striped bass, ocean salmon, steelhead, and river salmon.

The total catch of trout is apparently increasing each year.

The total catch of striped bass had shown a steady decline until 1957, which witnessed the best catch in 17 years.

Salmon fishing has shown a steady decline overall, since the alltime peak of 1954.

Steelhead fishing has shown an increase in total catch somewhat paralleling that of trout.

The black bass and catfish catches have remained relatively stable during the survey period.

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APPENDIX

TABLE 1A

Trends in California Trout Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	12,000,000	149,000	50	80	50
1937	11,900,000	151,000	48	78	50
1938	12,900,000	160,000	46	79	50
1939	12,800,000	179,000	49	71	37
1941	15,700,000	238,000	53	66	40
1942	16,400,000	234,000	54	70	42
1943	15,700,000	243,000	48	75	37
1946	17,660,000	357,000	47	49	25
1948	18,400,000	415,000	43	44	20
1949	16,700,000	431,000	43	39	--
1951	18,600,000	429,000	42	43	20
1953	22,300,000	530,000	44	42	22
1954	28,600,000	578,000	47	50	22
1956	26,200,000	640,000	46	41	21
1957	30,700,000	718,000	50	43	21

TABLE 2A

Trends in California Striped Bass Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	2,110,000	84,400	28	25	--
1937	2,040,000	81,900	26	25	--
1938	1,940,000	92,850	27	21	--
1939	1,880,000	89,300	24	21	12
1941	1,949,000	106,000	23	18	10
1942	1,680,000	88,200	20	19	--
1943	1,680,000	75,000	17	22	9
1944	1,420,000	--	--	--	--
1946	1,380,000	113,000	15	12	6
1948	1,650,000	161,000	17	10	5
1949	1,750,000	165,000	17	11	5
1951	1,490,000	144,000	14	10	5
1953	1,590,000	166,000	14	10	6
1954	1,440,000	158,000	13	9	5
1956	1,000,000	127,000	9	8	5
1957	1,890,000	230,000	16	8	5

TABLE 3A

Trends in California Salmon Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	196,000	25,000	8	8	--
1937	160,000	20,000	6	8	--
1938	178,000	22,000	6	8	--
1939	215,000	31,000	8	7	--
1941	253,000	38,000	8	7	--
1942	180,000	32,000	7	6	--
1943	274,000	31,000	7	9	--
1946	291,000	50,000	7	6	--
1948	321,000	65,000	7	5	2
1949	298,000	67,000	7	4	2
1951	564,000	79,000	8	7	3
1953	640,000	110,000	9	6	4
1954	860,000	142,000	11	6	3
1956	715,000	140,000	10	5	4
1957	700,000	147,000	10	5	3

TABLE 4A

Trends in California Steelhead Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1953	340,000	55,800	4.7	6	4
1954	340,000	56,500	4.6	6	3
1956	360,000	59,600	4.3	6	3
1957	600,000	85,300	6.0	7	4

TABLE 5A

Trends in California Black Bass Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	930,000	34,000	11	27	..
1937	849,000	33,000	11	26	..
1938	1,190,000	46,000	13	26	..
1939	1,340,000	67,000	18	20	..
1941	1,530,000	75,000	17	20	..
1942	1,340,000	66,000	15	20	..
1943	1,570,000	79,000	18	20	..
1946	1,700,000	104,000	14	16	..
1948	1,890,000	128,000	13	15	6
1949	1,160,000	116,000	12	10	5
1951	1,280,000	108,000	11	12	6
1953	2,300,000	161,000	14	14	9
1954	2,300,000	154,000	12	15	8
1956	2,550,000	164,000	12	16	9
1957	2,440,000	179,000	12	14	8

TABLE 6A

Trends in California Catfish Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	2,940,000	38,000	13	78	--
1937	2,810,000	43,000	14	65	--
1938	3,480,000	48,000	14	72	--
1939	4,333,000	75,000	20	58	--
1941	6,100,000	97,000	21	63	--
1942	8,250,000	110,000	25	75	--
1943	7,060,000	101,000	23	70	--
1946	6,530,000	149,000	19	44	--
1948	5,560,000	182,000	19	31	15
1949	3,930,000	161,000	16	24	12
1951	4,710,000	171,000	17	29	12
1953	7,500,000	225,000	19	33	15
1954	7,990,000	220,000	18	37	13
1956	6,970,000	217,000	16	32	10
1957	7,370,000	259,000	18	28	13

TABLE 7A

Statewide Angling Estimates for 1954

	Trout	Striped bass	Ocean salmon	River salmon	Steelhead	Black bass	Catfish	Panfish
Postal card reports	725	199	118	62	71	193	275	258
Successful anglers	578,000	158,300	92,300	49,300	56,500	153,500	219,500	205,200
Standard error	15,600	10,500	8,200	6,100	6,500	10,300	12,000	11,700
Percent of all licensees	46.6	12.8	7.4	4.0	4.6	12.4	17.7	16.6
Mean annual catch	50	9	7	5	6	15	37	53
Standard deviation	82.6	13.4	11.7	6.5	7.1	19.7	112.4	80.9
Standard error	3.1	0.9	1.1	0.8	0.8	1.4	6.8	5.0
Median annual catch	22	5	3	3	3	8	13	26
Total annual catch	28,600,000	1,440,000	660,000	200,000	340,000	2,300,000	7,990,000	10,970,000
Standard error	1,900,000	180,000	120,000	50,000	60,000	260,000	1,550,000	1,205,000

TABLE 8A

Statewide Angling Estimates for 1956

	Trout	Striped bass	Ocean salmon	River salmon	Steelhead	Black bass	Catfish	Panfish
Postal card reports	1,637	323	254	104	152	418	552	574
Successful anglers	640,000	127,000	99,600	40,800	59,600	164,000	216,500	225,000
Standard error	11,600	6,700	6,000	3,900	4,700	7,500	8,600	8,600
Percent of all licensees	46.5	9.2	7.2	3.0	4.3	11.9	15.7	16.3
Mean annual catch	41	8	5	5	6	16	32	44
Standard deviation	59.5	9.9	6.4	7.0	7.8	23.3	51.4	83.4
Standard error	1.5	0.6	0.4	0.7	0.6	1.1	2.2	3.5
Median annual catch	21	5	4	4	3	9	10	18
Total annual catch	26,200,000	1,000,000	500,000	220,000	360,000	2,550,000	6,970,000	10,020,000
Standard error	1,055,000	90,000	50,000	35,000	45,000	220,000	550,000	870,000

TABLE 9A

Statewide Angling Estimates for 1957

	Trout	Striped bass	Ocean salmon	River salmon	Steelhead	Black bass	Catfish	Panfish
Postal card reports	1,523	488	214	98	181	380	550	518
Successful anglers	718,000	230,000	101,000	46,200	85,300	179,000	259,000	244,000
Standard error	13,000	9,500	6,600	4,600	6,200	8,600	10,000	9,800
Percent of all licensees	50.1	16.0	7.0	3.2	6.0	12.5	18.1	17.0
Mean annual catch	13	8	5	5	7	11	28	31
Standard deviation	63.5	9.9	4.9	6.1	9.0	23.0	43.9	49.5
Standard error	1.6	0.4	0.3	0.6	0.7	1.2	1.9	2.2
Median annual catch	21	5	4	3	4	8	13	17
Total annual catch	30,660,000	1,890,000	480,000	215,000	600,000	2,410,000	7,370,000	7,680,000
Standard error	1,285,000	130,000	45,000	35,000	70,000	240,000	560,000	610,000

TABLE 10A

Number of Days Fished by California Anglers in 1954

Species	Number of reports	Angling days	Standard error	Percentage of total days	Mean days fished	Standard deviation	Standard error of the mean	Median days fished
Trout	767	5,962,000	334,900	46.1*	10	13.7	0.49	7
Striped bass	248	1,683,000	157,800	13.0*	9	9.8	0.63	6
Ocean salmon	130	457,000	69,900	3.5*	5	6.0	0.52	3
River salmon	75	302,000	47,500	2.3*	6	4.6	0.53	3
Steelhead	91	444,000	49,500	3.4*	6	6.1	0.20	4
Black bass	216	1,093,000	131,300	8.5*	7	9.2	0.65	4
Catfish	289	1,568,000	487,100	12.1*	8	9.7	0.59	4
Panfish	262	1,415,000	145,800	10.9*	7	9.4	0.60	4
Ocean fish and shellfish other than salmon	521	4,161,000	342,000	24.4†	9	17.6	0.76	4

* Percentage of inland fishing days only, but including ocean salmon.
† Percentage of all inland and ocean fishing days combined.

TABLE 11A

Number of Days Fished by California Anglers in 1956

Species	Number of reports	Angling days	Standard error	Percentage of total days	Mean days fished	Standard deviation	Standard error of the mean	Median days fished
Trout	1,597	5,638,000	171,400	43.2*	9	8.59	0.23	6
Striped bass	399	1,565,000	112,900	12.0*	10	11.03	0.55	6
Ocean salmon	252	494,000	47,600	3.8*	5	6.11	0.38	4
River salmon	138	433,000	66,900	3.3*	8	12.04	1.02	5
Steelhead	185	580,000	72,300	4.4*	8	11.16	0.82	5
Black bass	399	1,096,000	85,500	8.4*	7	8.74	0.44	4
Catfish	508	1,594,000	119,000	12.2*	8	11.20	0.50	5
Panfish	523	1,641,000	147,000	12.6*	8	14.92	0.65	5
Ocean fish and shellfish other than salmon	929	3,280,000	238,800	20.0†	9	18.61	0.61	5

* Percentage of inland fishing days only, but including ocean salmon.
† Percentage of all inland and ocean fishing days combined.

TABLE 12A

Number of Days Fished by California Anglers in 1957

Species	Number of reports	Angling days	Standard error	Percentage of total days	Mean days fished	Standard deviation	Standard error of the mean	Median days fished
Trout	1,489	6,318,000	260,500	41.4*	9	13.09	0.33	6
Striped bass	555	2,616,000	195,500	17.2*	10	15.04	0.64	6
Ocean salmon	233	549,000	47,000	3.6*	5	4.94	0.32	3
River salmon	129	426,000	52,200	2.8*	7	7.24	0.64	4
Steelhead	226	746,000	75,300	4.9*	7	7.84	0.52	5
Black bass	360	1,358,000	118,800	8.9*	8	11.24	0.59	5
Catfish	509	1,920,000	161,400	12.6*	8	13.20	0.58	5
Panfish	466	1,318,000	94,100	8.6*	6	7.20	0.33	5
Ocean fish and shellfish other than salmon	907	3,421,000	232,600	18.3†	8	14.38	0.48	5

* Percentage of inland fishing days only, but including ocean salmon.
† Percentage of all inland and ocean fishing days combined.

TABLE 13A

Mean Annual and Daily Catch Estimates for Successful Anglers

Species	Number of reports			Mean annual catch per angler			Mean days per angler			Mean catch per angler day		
	1954	1956	1957	1954	1956	1957	1954	1956	1957	1954	1956	1957
Trout	725	1,637	1,523	49.5	40.8	42.7	9.9	8.6	9.1	5.0	4.7	4.6
Striped bass	199	323	488	9.3	7.9	8.2	8.8	10.0	10.1	1.0	0.8	0.8
Ocean salmon	118	254	214	7.4	5.0	4.8	5.2	4.9	4.5	1.4	1.0	1.0
River salmon	62	104	98	4.6	5.3	4.7	5.5	8.4	6.6	0.8	0.6	0.7
Steelhead	71	152	181	6.2	6.0	7.0	6.5	8.0	7.4	1.0	0.8	0.9
Black bass	193	418	380	15.1	15.6	13.6	6.9	7.0	7.6	2.2	2.2	1.7
Catfish	275	552	550	36.5	32.2	28.4	7.7	8.1	8.4	4.7	3.9	3.3
Panfish	258	574	518	53.4	44.5	31.4	5.0	7.6	6.4	7.2	5.8	4.9

EXPERIMENTS WITH A VERTICAL BAFFLE FISHWAY[1]

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INTRODUCTION

Water development planning in California has been accelerated greatly during the last decade. One of the areas slated for early development is the Sacramento-San Joaquin Delta. This is an area in the central part of the State consisting of about 527,000 acres, and bounded roughly by the Cities of Sacramento, Antioch, Tracy and Stockton. The area contains approximately 43,000 surface acres of water comprised of about 500 miles of tidal sloughs and river channels, as well as several flooded islands.

The vast amounts of water that annually flow out of the delta and into the Pacific Ocean during the winter and spring long have been considered as a source for development by various agencies. Studies by the State Department of Water Resources have led to the conclusion that the most economically feasible plan would be to utilize upstream storage for conservation, and to construct various physical works in the delta channels for the purposes of flood and salinity control, and to assist in the transfer of water across the delta for use in the San Joaquin Valley. These several proposed developments are now known as the Delta Water Project. They were described in Bulletin No. 60 of the State Department of Water Resources (1957).

Basically, the plan consists of building control structures across the Sacramento River, Steamboat Slough, Holland Cut, Paradise Cut, and at Little Venice Island; constructing an isolated channel with an inverted siphon under the San Joaquin River to convey fresh water across the delta to major pumping plants for transport to areas of deficiency; and erecting delta flood control levees (Figure 1). The control structures would regulate the quantity of water passing into Suisun Bay from the Sacramento and San Joaquin Rivers, and would provide a means of maintaining a water surface elevation suitable for diversion of water across the delta. The isolated Cross-Delta Canal would deliver water of high quality throughout the delta, to the existing Tracy Pumping Plant, and to the proposed Feather River Project Pumping Plant. The master flood control levees would provide protection to delta lands.

The various fisheries dependent upon the Sacramento-San Joaquin Delta for passage through, or for part or all of their life cycle, are quite diverse and of large commercial and recreational importance. Species of fish concerned are king salmon *(Oncorhynchus tshawytscha)*,

[1] Submitted for publication December, 1958. This investigation was done as part of the work performed under Interagency Agreements 57-SA-2 and 8-213-S1 between the Departments of Fish and Game and Water Resources, and was financed by funds from the latter department.

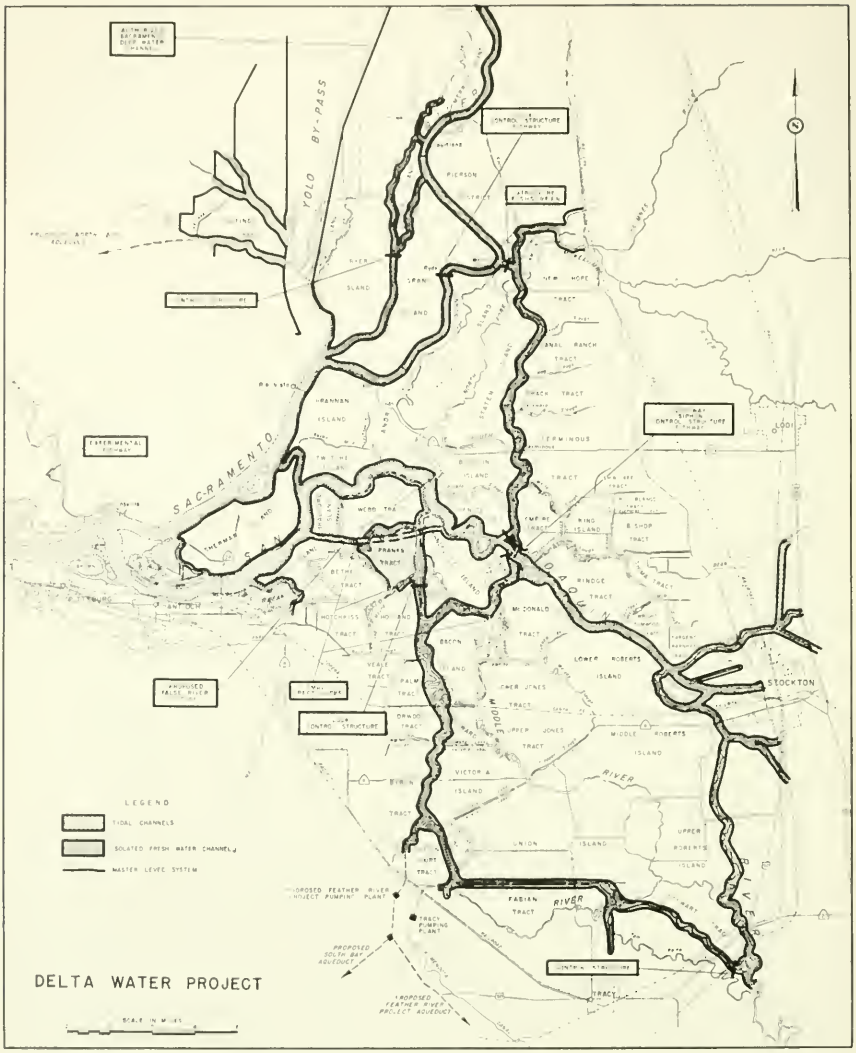

FIGURE 1. Map of Sacramento-San Joaquin Delta area showing principal features of the Delta Water Project.

silver salmon (*O. kisutch*), steelhead rainbow trout (*Salmo g. gairdneri*), striped bass (*Roccus saxatilis*), American shad (*Alosa sapidissima*), white sturgeon (*Acipenser transmontanus*), green sturgeon (*A. medirostris*), white catfish (*Ictalurus catus*), largemouth bass (*Micropterus salmoides*), bluegill sunfish (*Lepomis macrochirus*), green sunfish (*L. cyanellus*), black crappie (*Pomoxis nigromaculatus*), and a varied assortment of cyprinids and other species of lesser importance. The magnitude of the sport and comercial use of the major species is indicated in various papers (Calhoun, 1949; Pelgen, 1955; Skinner, 1955; Department of Fish and Game, 1958).

THE PROBLEM

Construction of the Delta Water Project would result in physical barriers across channels presently serving as migration routes for anadromous fishes. The barrier planned for construction in the Sacramento River at Ryde would present a block to the various species of fish using the Sacramento River and its tributaries for spawning purposes. The barrier would consist of vertical-lift steel gates, resting on a pile-supported concrete sill. A varying amount of water would be released at all times to satisfy downstream water requirements. These releases would provide good quality water in the Sacramento River for several miles below the control structure and insure a gradual transition from fresh to saline water, similar to existing conditions. Water elevations on the lower side of the barrier would vary, depending upon tidal stages. There would be an expected head differential on the order of five feet at the barrier at low tide. Water elevation on the downstream side of the barrier would possibly be a foot or two higher than on the upstream side at periods of highest tide.

The problem of inducing migratory fish to pass a barrier of this size would appear to be quite simple, as indeed it should be if only salmonids were involved. However, the situation is complicated by the fact that striped bass, shad, and sturgeon are reluctant to use conventional pool and jump-type fish ladders. This condition requires a fishway of different design from those currently used in California. The vertical baffle type tentatively was selected as the most promising, since it is being successfully used in other areas for passing salmon and steelhead (Talbot, 1950; State of Washington, 1957). In an effort to determine if the vertical baffle type would be suitable for all of the anadromous species in the delta, an experimental fishway was constructed near the delta in 1956, primarily for conducting tests with striped bass, shad, and sturgeon.

DESCRIPTION OF INSTALLATION

The fishway was constructed on the Grizzly Island Waterfowl Management Area. This site was selected for several reasons. First, it is located on state-owned property; second, use could be made of an existing headgate and drainage ditches; and third, it is located near areas in which fish could be collected and transportation problems minimized.

The headgate supplying water to this installation is located on the westerly side of Montezuma Slough, about three miles downstream from its branching from the Sacramento River near Collinsville (Figure 1). A pipe 2 feet in diameter and 100 feet long leads from the headgate to a ditch inside the levee on Grizzly Island. Two 50-foot by 50-foot square pools were dredged, one (designated the forebay) a few feet inside the island from the inlet pipe, the other (designated the afterbay) 40 feet distant from the first pool. The fishway was constructed between the two pools (Figure 2). Each pool was dredged to an elevation of minus seven feet mean sea level, with a trench 2 feet deep and 10 feet wide dug from the fishway to the opposite end of each pool. A flashboard structure with a removable, sharp-crested rectangular weir was constructed in the drainage ditch a few yards downstream from the lower pool to regulate the water surface height in this pool

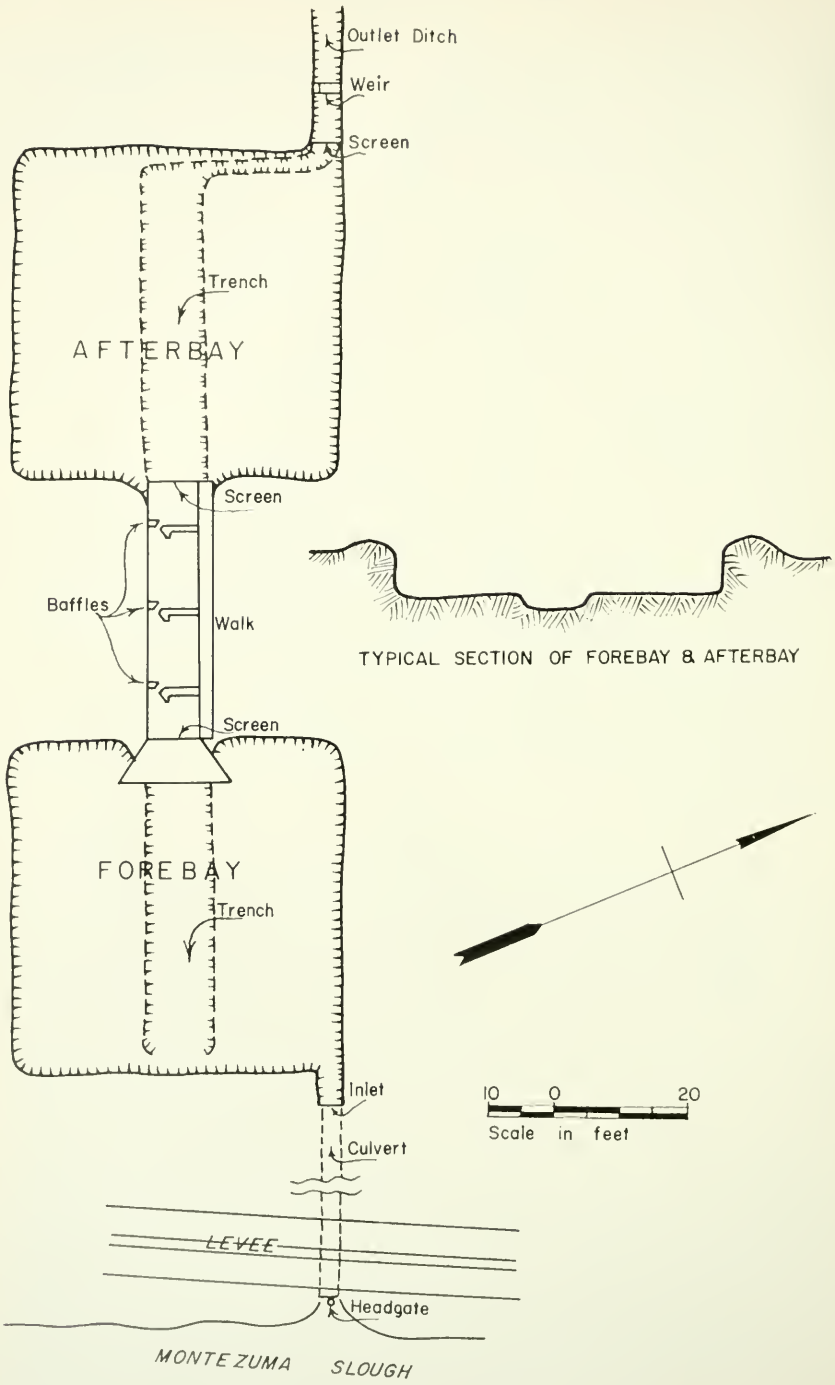

FIGURE 2. Diagram of experimental fishway and ponds.

and to measure the flow of water through the installation. A screen was installed at the lower end of the lower pool, just above the weir.

The fishway itself was constructed of five-eighth-inch plywood over a redwood timber frame. It is 48 feet long, including an 8-foot-long flare at the upstream side to facilitate water entry. Three baffles were constructed to form two 8-foot by 12-foot bays in the fishway, the entire structure being six feet deep. Baffle openings were 12 inches wide. A walkway was constructed along one side, and removable screens were placed at both ends of the fishway. The floor of the fishway is at minus seven feet elevation.

A system of drainage ditches carries the water from the fishway to a pump which lifts it back into Montezuma Slough.

OPERATION OF EXPERIMENTS

Capture of Fish

Fish used in the experiments were captured by several different methods. All of the striped bass, shad, and sturgeon were caught with drift gill nets, set in either the Sacramento or San Joaquin Rivers near their confluence. One group of salmon was captured by this method. A net was set in the channel from the research vessel "Striper" and left for usually 15 to 30 minutes. It then was hauled in, and the fish removed and immediately put into a live tank containing circulating river water. The fish then were transported to the fishway, which was located from three to six miles distant. Fish were usually in transit about 30 minutes.

One group of salmon and steelhead was taken by large fyke nets set in the Sacramento River near Fremont Weir, about 85 miles upstream from the fishway. They were transported to the fishway in a 150-gallon fish planting truck.

White catfish were captured in hoop nets set in Mayberry Slough, about six miles upstream from the fishway. These nets were left in the water about 60 hours, and the fish were transported to the fishway by boat.

Operation of Fishway

Operations at the fishway were begun early in 1957. Three groups of fish were used during February and March. These trials were conducted mainly to work out details of transporting fish and operating the fishway. Water temperatures during this period ranged from 46 to 56 degrees F., and the fish were not especially active.

The usual method of operation of experiments starting in May was by the following procedure:

1. Fish were captured and put in the afterbay. They were left in the pond for a period of time to adjust to this habitat. The time varied from one to 34 days, but in most cases experiments were begun within a day or two. During this period, a small flow of water was allowed to enter the fishway. All fish used in these experiments were adults, with the exception of sturgeon which ranged from 20 to 53 inches total length.

2. Before the experiments began, water temperature in the afterbay was recorded, then the headgate was opened and water allowed to enter the installation until the desired flow and elevations in the ponds were

FIGURE 3. Adjusting the screens on the experimental vertical baffle fishway. Afterbay in foreground. Photograph by W. Dillinger.

reached. The screens at both ends of the fishway then were raised clear of the water, and the headgate thereafter manipulated to produce a constant flow through the structure. Readings of staff gauges in both ponds and in each pool of the fishway were made at half-hour intervals.

3. At the end of the desired period, the screens were lowered and the headgate closed. The weir was opened, and the water was allowed to drain from the ponds. During most of the experiments, a pump was used to facilitate drainage.

4. When the water had drained approximately to the level of the bottom of the fishway, a seine was used to capture fish from the forebay for recording and marking. Usually two or three sweeps were made through the trench. Fish usually were returned to the afterbay after being marked.

5. The headgate then was opened, and water allowed to fill the ponds. At the conclusion of a series of experiments, fish were seined from both bays and returned to Montezuma Slough.

From one to nine different trials constituted each series. Usually only one trial was conducted during any one day, although on several occasions two trials were run, in which case one would be during the day and the other at night. All trials were begun during the incoming tide, so that high tide would occur some time near the middle of the trial, and full advantage could be taken of the available head of water at the headgate. During periods of low tide, little or no water would flow through the headgate.

Temperature of the water flowing through the fishway was taken during each trial.

Flow through the installation was determined by reading the water level in the afterbay on a staff gauge near the outlet weir. A rating curve had been previously developed from which the rate of flow over the weir could be determined for variations in head of each .01 foot.

Velocities in the slot of the lower baffle were determined by dividing the computed water flow through the fishway by the cross-sectional area of the slot that contained water. This gave an average figure for the slot, without taking into consideration friction at the sides and bottom, or other factors. Measured velocities in the thread of the jet (area of maximum slot velocity) were about 1.6 times as great as computed velocities. This maximum velocity, however, occurs in but 5 to 10 percent of the cross-sectional area. Velocities in the upper slots were slightly less than those in the lower one, since the floor of the fishway is level.

RESULTS OF EXPERIMENTS

Spring, 1957

Results of experiments conducted during May and June, 1957, with striped bass, shad, and sturgeon are given in Table 1. During this time, three groups of fish were used. Varying numbers of each species passed through the fishway during each series, with the exception of striped bass during the last series. Most of these latter fish, however, had completed spawning activities before being caught and put in the fishway. This condition probably reduced their urge to move upstream through the fishway.

TABLE 1

Fishway Operations: Spring 1957

Date of experiment	Length of experiment (hours)	Flow (cubic feet per second)	Average slot velocity (feet per second)	Water temperature (degrees F.)	Number of fish passing through fishway and number of fish available for passage*			
					Striped bass	American shad	White sturgeon	Green sturgeon
5/3	3½	7.3	2.1	64	3 (36)	1 (7)	2 (7)	1 (1)
5/6	4	12.3	3.3	66	0 (32)	0 (7)	0 (7)	0 (1)
5/7	4	9.8	2.7	65	0 (31)	0 (7)	2 (7)	0 (1)
5/8	4	8.6	2.4	65	5‡ (27)	1 (7)	1 (7)	1 (1)
5/9	4	11.0	3.0	65	2‡ (27)	1 (7)	0 (7)	0 (1)
5/10	4	13.3	3.5	64	5‡ (28)	0 (7)	0 (7)	1 (1)
5/13	3½	14.8	3.9	65	1‡ (28)	1 (6)	0 (7)	0 (1)
5/20	4	16.2	4.2	64	0 (20)	1 (14)	0 (13)	– –
5/21	4	17.6	4.5	62	2 (20)	3 (13)	1 (13)	– –
5/22	3½	16.8	4.3	61	2 (20)	0 (13)	2 (13)	– –
5/24	4	17.9	5.0	60	0 (18)	0 (9)	0 (13)	– –
5/25	4	16.8	4.7	60	0 (17)	0 (8)	0 (13)	– –
5/27	4	17.0	4.4	63	1 (14)	0 (7)	0 (13)	– –
5/28†	4	17.6	4.5	63	0 (14)	0 (7)	0 (13)	– –
5/28	4	17.8	4.7	63	0 (14)	0 (6)	0 (13)	– –
5/29†	4	15.0	4.0	63	0 (13)	0 (6)	0 (13)	– –
6/5	4	17.6	4.5	67	0 (6)	0 (3)	0 (10)	– –
6/6	4	16.5	4.2	67	0 (5)	1 (3)	1 (10)	– –
6/7	4	16.8	4.3	67	0 (3)	0 (3)	0 (10)	– –

* Number of fish available for passage is enclosed in parentheses.
† Operated at night in darkness.
‡ Several fish put in upper bay as "attractors."

The first group of fish was captured in late April, and the first experiment was run for a period of 26 hours during April 29 and 30. Two striped bass out of 39, two shad out of seven, two white sturgeon out of seven, and the one green sturgeon passed through the fishway during this experiment. Flows through the fishway during this time varied from 2 to 20 cubic feet per second; therefore, velocities were quite low during certain periods.

Seven subsequent trials were conducted for periods of from 3½ to 4 hours on the above-mentioned group of fish; and during a total of 27 hours, eight striped bass, four shad, and three white sturgeon passed through the fishway. Of these, two bass and two sturgeon negotiated the fishway twice, and the green sturgeon swam through the fishway three times out of the seven opportunities. During this series, greater success was realized for striped bass when from one to three bass were put in the forebay as "attractors" for other bass.

Fish used in experiments during the latter part of May were caught in mid-May. Nine trials covering a total of 35½ hours were conducted. During this series, 3 striped bass out of 20, 4 shad out of 13, and 2 white sturgeon out of 13 passed through the fishway. Two bass and one sturgeon repeated the process. Two of the trials were conducted at night but with no positive results.

The third group of fish used was captured in early June and given three opportunities to use the fishway, for a total of 12 hours. During this series, one shad out of three and one sturgeon out of 10 utilized the fishway. Six spawned-out striped bass were put in at the start of experiments; however, three had died in three days and none passed through the fishway, so the experiments were concluded for the season.

Fall, 1957

Experiments during September and October consisted of four trials with two groups of fish (Table 2). The first group consisted of eight king salmon and 10 steelhead caught in the Sacramento River near the Fremont Weir, 23 miles upstream from the City of Sacramento. These fish were used because of the general unavailability of fish in the delta at this time. Three trials were conducted on these fish for a total of eight hours, during which time five salmon and six steelhead moved through the fishway. Two salmon and two steelhead negotiated the distance twice.

The second group consisted of four king salmon collected in the delta near the mouth of Montezuma Slough on October 2. On October 4, a 2½-hour experiment was sufficient for the only remaining live salmon to move through the fishway. Operations were concluded with this experiment.

During both of these series, one white sturgeon (53 inches total length) was in the afterbay, but did not move through the installation.

Spring, 1958

Operations during 1958 began when fish were captured on March 26 and transferred to the fishway. However, unseasonal heavy rains and flood conditions of Central Valley streams caused high water in the delta, and precluded fishway operations during virtually the entire month of April. Experiments with the fishway finally were resumed on

TABLE 2

Fishway Operations: Fall, 1957

Date of experiment	Length of experiment (hours)	Flow (cubic feet per second)	Average slot velocity (feet per second)	Water temperature (degrees F.)	Number of fish passing through fishway and number of fish available for passage*		
					King salmon	Steelhead	White sturgeon
9/24	2	21.0	5.2	69	0 (8)	0 (10)	0 (1)
9/25	3	18.0	4.6	68	3 (8)	5 (10)	0 (1)
9/26	3	20.0	5.0	68	4 (7)	3 (10)	0 (1)
10/4	2½	17.3	4.4	66	1 (1)	- --	0 (1)

* Number of fish available for passage is enclosed in parentheses.

April 29 and continued through May 29 (Table 3). During this time three groups of fish were used. The first group consisted of striped bass and shad collected on April 28, as well as several bass remaining in the afterbay from the catch of March 26. Fish put in the afterbay on April 28 were marked by clipping a fin to distinguish them from the previous plant. During the 13½ hours the fishway was in operation for this group of fish, two bass from the March plant and two bass from the April plant, out of a total of 17 available, negotiated the fishway. One bass from the latter plant passed through the fishway twice on successive trials. One of two shad passed through the fishway during this series of tests.

The next group of fish was captured on May 12, and experiments began the following day. Five trials—each of four hours duration—were conducted, during which time 2 striped bass out of 15 moved through the fishway, one bass accomplishing the move twice. On the first

TABLE 3

Fishway Operations: Spring, 1958

Date of experiment	Length of experiment (hours)	Flow (cubic feet per second)	Average slot velocity (feet per second)	Water temperature (degrees F.)	Number of fish passing through fishway and number of fish available for passage*		
					Striped bass	American shad	White catfish
4/29	3	16.8	4.3	60	0 (16)	1 (2)	-- --
4/30	2½	18.5	4.7	60	0 (17)	0 (1)	-- --
5/1	4	18.8	4.8	60	4 (15)	0 (1)	-- -
5/2	4	20.2	5.1	60	1 (13)	0 (1)	-- --
5/13	4	17.3	4.5	62	0 (15)	2 (13)	-- -
5/14	4	17.9	4.6	62	1 (12)	0 (9)	-- --
5/15†	4	20.0	5.0	62	0 (13)	0 (7)	-- --
5/15	4	16.8	4.3	62	1 (13)	0 (7)	-- --
5/16	4	18.2	4.7	63	1 (7)	0 (1)	-- --
5/27	4	19.7	5.0	65	1 (11)	-- --	1 (75)
5/27†	4	20.2	5.1	65	0 (10)	-- --	0 (75)
5/28	4	18.5	4.7	65	1 (10)	-- --	15 (75)
5/29	4	19.0	4.8	63	1 (7)	-- --	22 (35)

* Number of fish available for passage is enclosed in parentheses.
† Operated at night in darkness.

trial, 2 out of 13 shad moved through the fishway, but no positive results were achieved with this species during subsequent tests. One trial was conducted at night, with no fish moving through the fishway.

The white catfish were placed in the pond on May 22, and the last group of bass was captured and put in the afterbay on May 26. Four trials, each four hours in length, resulted in 3 bass out of 11 moving through the installation. Out of 75 white catfish, 38 moved through the fishway during these tests, and an additional eight fish were stranded in the fishway at the end of the tests, indicating that they were moving through the fishway at the termination of the experiments. The second test of this series was run at night, and was the only one in which some fish of both species did not negotiate the fishway.

DISCUSSION

Water Conditions

Salinity of water used at the fishway was determined during some of the tests by measuring the chloride ion content of the water. Salinities during the spring of 1957 ranged from 7 to 548 parts per million (p.p.m.); during the spring of 1958 from 15 to 65 p.p.m.; and during the fall of 1957 from 185 to 3,370 p.p.m. Part of the wide range, especially that found during the fall of 1958, was because some samples were taken during high tide (the high readings), and some during low tide (lower readings). The water in Montezuma Slough was brackish during high tide the latter part of September, 1957, but was relatively fresh during other times of the year when the fishway was operated.

Water in the delta is characteristically quite turbid. Tule debris, peat material, and suspended inorganic matter are present in large amounts throughout the year. No Secchi disk readings were made during this study, but they usually vary between several inches and a foot or more in this general area.

Application of Experiments

Results of this study indicate that individual fish of all the species tested will use a vertical baffle fishway under the conditions described. White catfish were 60 percent successful in passing through the fishway in 16 hours, steelhead were 60 percent successful in eight hours, and two groups of king salmon were 67 percent successful in an average of five hours per group. Five groups of striped bass were 22 percent successful in negotiating the fishway, each group having an average of 22 hours opportunity to pass through. This figure disregards the spawned-out group used in June, 1957. American shad were 32 percent successful in passing through, each of five groups having an average of 22 hours opportunity. Twenty percent of the white sturgeon passed through the fishway during an average of 25 hours for each of three groups. This does not consider the one fish used in the fall of 1957.

These results are encouraging in view of the fact that most of the fish were in rather poor physical condition after being caught in the gill nets, and the habitat in the fishway and ponds was quite dissimilar to that existing in the rivers where the fish were captured. Whether striped bass, shad, or sturgeon would efficiently use a fishway of this design if it were constructed at a water project cannot be answered

conclusively from these experiments. This answer must await the actual construction of a barrier and fishway, at which time a proper evaluation could be made.

Experiments indicate that most of these species are not especially active during hours of darkness. During the four tests run at night none of the bass, shad, sturgeon, or catfish moved through the fishway. No attempt was made to operate the fishway at night when either salmon or steelhead were available for passage.

During experiments in the spring of 1957, no fish passed through the fishway with flows producing average velocities greater than 4.5 feet per second through the baffle openings. These flows resulted in velocities in the thread of the jet of about 7.2 feet per second. In 1958, however, striped bass and white catfish both used the fishway at calculated average velocities of about 5.0 feet per second through the slot. Maximum velocities in the jet were then about 8.0 feet per second. Both king salmon and steelhead successfully negotiated the fishway at average velocities of 5.0 feet per second in the fall of 1957. Shad did not use the fishway at velocities greater than 4.5 feet per second; however, during most of the experiments only a few shad were present, and these were in poor physical condition. As a general rule, shad passed through the fishway during the first several tests, then failed to move upstream. There was always a heavy initial mortality among shad caught by gill nets, and usually very few individuals remained in the pond after the first day or two.

Striped bass were adversely affected by the netting and transporting operations, although not to the extent the shad were.

ACKNOWLEDGEMENTS

I wish to express my gratitude to Herbert Howlett, Hydraulic Engineer, Department of Water Resources, who was largely responsible for the original idea of the experiments, and was instrumental in securing funds for the investigation.

Randolph Lipelt, Jr., Civil Engineer, Department of Water Resources, was responsible for construction of the fishway.

Vincent Catania, Netman-boatswain, provided very valuable assistance both in the capture of most of the fish and in designing a live tank for use in transporting the fish to the fishway.

Lawrence Rubke, Game Manager, and personnel of the Grizzly Island Waterfowl Management Area assisted by digging the ponds and clearing the drainage ditches, and provided a pump for drainage of the ponds.

James Ryan, Fisheries Biologist, assisted with the fishway operations during the spring of 1957.

SUMMARY

Construction of the Delta Water Project in the Sacramento-San Joaquin Delta will result in physical barriers placed in channels currently used by anadromous fish populations of the Central Valley. Several of the species involved—namely, striped bass, American shad, and white sturgeon—are reluctant to use fishways of the type currently in use in California. Because of this, a vertical baffle fishway was con-

structed for testing these species to determine if they would utilize a fishway of this design.

Experiments were conducted when the fish became available in their natural habitat. For the most part, they were captured by drift gill nets and transported to the fishway by boat. Each test consisted of a relatively constant flow of water passing through the fishway for a given length of time, usually about four hours.

Results of the experiments indicate that some individuals of all the species tested will use a vertical baffle fishway under captive conditions. Sixty percent of the white catfish, 60 percent of the steelhead, 67 percent of the king salmon, 22 percent of the striped bass, 32 percent of the American shad, and 20 percent of the white sturgeon used were successful in passing upstream through the fishway.

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IN MEMORIAM

H. B. NIDEVER

January 28, 1959, H. B. Nidever, aged 78, died at his home in La Crescenta where he had lived since his retirement in September, 1941, from the Division of Fish and Game, after 33 years of outstanding accomplishment. He entered state service June 29, 1908, as boatman in the San Francisco Bay and Delta area. He assisted N. B. Scofield in some of the pioneer research on king salmon. From this association grew the plans for, and policies of, the Bureau of Marine Fisheries. In the following years, Nidever had charge of the marine patrol in Southern California and after 1928 he directed the statewide ocean patrol until his transfer to San Francisco in 1930. In the following years he worked in the Delta on salmon and striped bass problems. It was during this time that he developed the program for measuring the sport catch of striped bass.

Throughout his years of service, Nidever was a strong supporter of marine fisheries research and the program of the State Fisheries Laboratory at Terminal Island. He played a leading part in planning and introducing the triplicate receipt catch record system now used throughout the State and in establishing a sport catch record system in Northern California. Above all, his sterling character won personal friends and the respect of all the men with whom he dealt.

To Mrs. Nidever and the family, the personnel of the department both present and retired, extend heartfelt sympathy.—*W. L. Scofield, Marine Fisheries Branch.*

REVIEWS

Guide to the Fishes of New Mexico

By William J. Koster; University of New Mexico Press in co-operation with New Mexico Department of Game and Fish, Albuquerque, New Mexico, 1957; vii+116 pp., $1.

This is a preliminary account to be followed by a detailed study of New Mexico fisheries. It is intended to provide answers to the questions commonly asked about fishes by New Mexico anglers and other nonspecialists. Brief general sections on the feeding, breeding, utility, size, and capture of New Mexico fishes are followed by a description of each kind.

The main aid to identification is a series of original outline drawings, one for each species, made with much care from photographs of specimens. These should be very helpful to the nonspecialist. Diagnostic characters, distribution, life history, importance, fishing methods, and origin of introduced forms are outlined briefly for most species.

The book could scarcely be more appropriate for its intended audience. It will also be a convenient reference for fisheries workers while they await completion of Mr. Koster's definitive work.—*Alex Calhoun, California Department of Fish and Game.*

The Freshwater Fishes of Canada

By E. P. Slastenenko; Kiev Printers, Toronto, Canada, 1958; 385 pp., $15.

Mr. Slastenenko has gathered together and abstracted the published information on Canadian freshwater fishes. His book contains a section on each species, which includes a synonymy, a detailed description, and general information on size, habitat, food habits and commercial value. Growth rates are illustrated for some of the more important fish.

Most species are illustrated. The drawings were borrowed from other authors and they have suffered greatly in the process.

There are keys to the families, genera, and species; a glossary, and a distributional summary in tabular form.

The text has more than its share of typographical errors.—*Alex Calhoun, California Department of Fish and Game.*

Living Resources of the Sea

By Lionel A. Walford, The Ronald Press Company, New York, 1958; 321 pp., $6.

Only the last five chapters directly pertain to the title of this book. These five chapters make up Part II entitled "The Resources of the Sea," and consist largely of a general survey of the principal groups of animals and plants valuable to man. They stress areas of ignorance rather than areas of knowledge.

It is Part I, "The Marine Wilderness," which conveys the message the author so aptly delivers. These first 12 chapters discuss marine fisheries research and management. In this section the research problem is defined, and the types of research needed to supply the answers are discussed. What is more important, the author severely criticizes many existing management practices and the antiquated approach of research workers attempting to solve some of the more trivial problems. "The most obvious lack in marine research," he says, "is the pursuit of principles." He debunks several commonly held views which are clearly implied in the many proposals of laws advanced for conservation purposes.

He has this to say of literature about conservation of fishery resources:

> "Most of it advances no new thought at all: it merely repeats what has been said before, using uncritically the same examples to support the same arguments over and over.
>
> "This state of affairs results largely from the fact that the bulk of the literature is produced by government administrators to order, on short notice—'I need

a speech for Friday.' How can anything objective and philosophical be thought through under such pressure."

He makes a strong plea for better and more fundamental research into areas which have been neglected or avoided, such as the study of ecological principles. He decries the degeneration of museums, once the center of research activity.

Many of his comments are terse and to the point; others are strongly flavored by his personal philosophy.

In any event, whether you agree or disagree with his views, you will find they stimulate considerable thought. This book should be read by all marine research workers and fisheries managers.—*John Radovich, California Department of Fish and Game.*

Birds of Alaska

By Ira N. Gabrielson and Frederick C. Lincoln; the Stackpole Company, Harrisburg, Pa., and the Wildlife Management Institute, Washington, D. C., 1959; 922 pp., frontispiece and nine color plates, one figure, one map, $15.

This book, *Birds of Alaska*, consists of chapters on the history of ornithology in Alaska, interesting aspects of Alaskan ornithology, migration, Alaskan ecological zones, game bird introductions into Alaska, detailed descriptions of the birds of Alaska, a gazetteer of geographic location, and an extensive bibliography. Also included is a list of 21 birds which have been reported in Alaska, but for which there are only doubtful records and of which no preserved specimens exist.

Fourteen years of research and writing by the authors were required to assemble and catalogue the information contained in this book. It is a single reference encompassing a vast amount of information on Alaskan ornithology from the early period of Russian exploration to the present date. The list of recognized Alaskan birds consists of 321 species which are represented by 414 races.

The chapter on migration describes the routes traveled through Alaska by the migrant birds en route to and from the wintering areas. Migration routes funnelling into the four flyways of North America, the Asiatic flyway, and the Pacific oceanic route are discussed briefly. A map of Alaska, illustrating these routes, would have made this section complete.

Life zones are discussed at length and other authors' interpretations of ecological zones are presented. Characteristic birds, mammals and plants are noted for each zone. Here again, the addition of a pertinent map or black-and-white photographs illustrating the various types of zones would have given the reader a better insight of the topography of a state many of us might never see.

The chapter on introduced game birds gives a brief history of introductions covering five species of pheasants and one species of chukar partridge.

The bulk of the book is devoted to presenting descriptions and ranges of the birds classed as residents, migrants or casuals of Alaska. The birds are grouped by families and a short description is given of the general characteristics of the family. Each species or subspecies is discussed in detail. The common name, scientific name and native Indian or Eskimo names are given. The description of the bird is presented as follows: total length, weights (in some cases), adult and immature plumages, and downy young. A description of the nest and number and color of the eggs is also included. A brief description is given of the general worldwide breeding and wintering ranges of birds found in Alaska. This is followed by a more detailed discussion of their range in Alaska. Haunts and habits are described and many interesting facts are given that are aids in locating and observing the different species in Alaska. The above section seems to be adequate in most instances but there is a noticeable lack of illustrations. The color plates also leave something to be desired.

Following the text of the book is a gazetteer of geographical locations and a map showing Alaska divided into 11 regions. Alaskan localities are listed alphabetically, including the number of the region in whch the locality is found. To those readers who are unfamiliar with Alaskan geography, this section is indispensible.

On the subject of bibliography, the authors state, "It has been our objective to compile a bibliography of Alaskan ornithology that would be as complete as possible." To this end they have definitely succeeded, with 55 pages of titles included in this section.

The book is well indexed; common and scientific names are cross-referenced.

In general, the book is well done and is recommended as a worthwhile addition to the reference library of anyone interested in ornithology.—*A. E. Naylor, California Department of Fish and Game.*

The Bobcat of North America

By Stanley P. Young; the Stackpole Company, Harrisburg, Pa., and the Wildlife Management Institute, Washington, D. C., 1958; xiv plus 193 pp., illus., $7.50.

This is the fourth of a series on the larger North American predators by Stanley P. Young. Like the others, it is written in a simple, natural manner. The author has avoided the use of highly technical language wherever possible and has produced another book that is very informative and interesting.

Instead of using the reader's time with the taxonomy of the bobcat, he has emphasized the practical aspects. The chapters on habits and characteristics, parasites and diseases, economic status, and hunting and control are a wealth of information to the amateur and professional alike. If a person wishes to know the differences between the subspecies of *Lynx rufus*, he will have to look elsewhere. The chapter on races of bobcats merely lists them, gives the type locality and range of each. No description is given.

The author has combined a long background of personal observations and correspondence with forest rangers, trappers, and wildlife technicians with a tremendous amount of research into literature. Eyewitness accounts of bobcats in action are present throughout. An indication of the amount of research involved in compiling this book is the bibliography of 46 pages. This alone might be worth the price of the book to the real student of the bobcat.—*William H. Thomson, California Department of Fish and Game.*

Statistical Theory

By Lancelot Hogben; W. W. Norton and Company, New York; 510 pp., $9.

Author Hogben has moved out of the popular field *(Mathematics for the Millions and Science for the Citizen)* in his latest book entitled *Statistical Theory*. This long and sometimes confusing book begins by tracing in detail the development of the theory of probability from Pascal to modern day. According to Hogben, all was well with the field of statistics until the social scientists and biologists "climbed aboard" the momentum-gaining "bandwagon." By omission, however, he seems to praise the physical scientists.

Lancelot Hogben, who is a biologist, has little but criticism for present-day statistical usage, particularly in the biological sciences. He is critical of what statistics and probability are supposedly accomplishing. He feels that more and more scientists are relying upon methods which are little understood and often "cookbooked" to completion. Hogben believes that statisticians have become so involved with neat and detailed mathematics that the real reasons for the existence of their science has been forgotten, viz., its value in deriving knowledge of real phenomena and in giving power to biological, social and psychological research.

After reading *Theory*, the reader must inevitably ask himself "Are Hogben's criticisms valid?" If they are accepted at face value, he must be placed in the role of one who is attempting to destroy in a moment the careful "progress" of three centuries. If only certain facets of his indictment are accepted, e.g., ritualistic use of statistics without understanding, it appears that a healthy new outlook toward biometrics can be realized.

Statistical Theory is not a book for the run-of-the-mill biologist or even for some highly trained and skilled scientists. Unless his background in statistics, calculus, logic and probability theory is extensive, the potential reader will certainly not be familiar with much of the vocabulary. However, the constant user of biostatistics or the professional biometrician would do well to have this book in his library.—*Howard L. Huddle, California Department of Fish and Game.*

Conservation in America

By Dorothy Childs Hogner; J. B. Lippincott Company, Philadelphia and New York, 1958; 240 pp., $3.75.

Americans need to be constantly alerted to the danger of losing our natural resources. The coming generations have a right to expect us to do our duty. The author aims to make our duty clear.

The book is well written in a free-flowing style which is both entertaining and informative. Its appeal, however, will be to the layman rather than the professional or serious student of conservation.

Coverage of the entire field of conservation from its early history to the present and a review of current activities by public and private interests to maintain our natural resources is the author's goal. A trained biologist will consider the treatment of many subjects superficial.

Nevertheless this book will prove quite informative for the average American reader. The story of conservation is told in such dynamic statements as the description of our past history. "It is a really terrible, astounding unbelievable tale of wanton wholesale destruction of a rich Country; of slaughter of wildlife; of mass destruction of forests * * * it is a story of waste, waste, waste."—*Willis A. Evans, California Department of Fish and Game.*

Fishing America

Edited by Edward A. Hamilton and Charles Preston; Doubleday & Company, New York, 1958; 128 pp., illus., $5.95.

Anyone who enjoys looking at fishing pictures will revel in this extensive and varied array of excellent photographs portraying all kinds—almost—of angling in the United States and Canada. Almost—for I missed seeing at least one photograph of a western pack trip.

Following a brief introduction which sketches the development of angling from the earliest times, the book is divided into four major parts: Northern Fresh Water, Southern Fresh Water, Northern Salt Water, and Southern Salt Water, each amply and richly illustrated with both color and black-and-white photographs of fishing spots and action. The pictorial record is supplemented by information such as fish species indigenous to the area, recommended equipment, and record catches. Ready for an armchair cruise?—*Leo Shapovalov, California Department of Fish and Game.*

The Angler's Companion

By Bernard Venables; George Allen & Unwin Ltd., London, 1958; 224 pp., illus. American distributor: The Macmillan Company, 60 Fifth Avenue, New York. $12.

Bernard Venables, Editorial Director of the *Angling Times* and author of a number of books on angling, has written a thoroughly delightful account of angling in British waters and the fishes for which angling is done. (Venables, a professional painter, illustrator, and designer, not only wrote the book, but also illustrated it and designed its typography, layout, jacket, and binding.)

The author writes poetically and with affection, coupled with an intimate knowledge of the waters and the countryside.

To the American angler a whole new sphere of angling is revealed—the highly specialized art of coarse fishing. The author writes with respect and admiration about the roach, the rudd, the bream, and others which are sought as avidly by their own devotees as are the trout, the salmon, and the grayling. It is only if the American angler has read a book like this one and steeped himself in the flavor of British angling that he can look with less than scorn on such a phrase as "brilliant fishing for coarse fish."

The halcyon days of angling have passed from many of Britain's rivers with the creeping spread of industrial pollution, especially to their lower courses—"the runs of migratory fishes no longer come"—but it is heartening to read that some improvement, albeit gradual, is coming about as a result of strenuous efforts.

The American angler is bound to be intrigued by the bewildering array of specialized rods in use, such as double-handed salmon fly rods up to 16 feet in length and roach poles up to 20 feet long. Such specialized equipment and specialized methods of fishing were developed as fine arts by individuals and their followers who formed the various "schools of angling." (Phrases such as "the great school of Nottingham angling" create an aura of romanticism.) Much of this specialized fishing is done at night.

California anglers embroiled in the current controversy over the propriety of cheese as a bait may well ponder over some of the traditional coarse fish baits listed: silkweed algae, elderberries, small boiled potatoes, and macaroni. This is not to say that other baits and lures are neglected. They are not, and are described and

illustrated fully, as are methods and techniques. There is instruction in bottom fishing, fly fishing, and spinning. Flies and plugs are richly illustrated in color, and the fishes are portrayed by appealing drawings.

American anglers may think better of their own plight when they read that "for practical purposes, there is no such thing in Britain as a public right to fish in nontidal waters. All nontidal fishing, with a few small exceptions, belongs to someone who has the right to refuse or allow fishing as he wishes.

"Angling is done for the delight it gives." All who share this point of view will thoroughly enjoy this book, and those who do not may well adopt it after reading "The Angler's Companion."—*Leo Shaporalor, California Department of Fish and Game.*

Angler's Guide to the Salt Water Game Fishes, Atlantic and Pacific

By Edward C. Migdalski; the Ronald Press Company, New York, 1958; 506 pp., numerous black-and-white plates and text figures. $7.50.

This is a rather good example of a writer taking in just a bit too much territory and getting involved in the fauna of an area about which he has little or no personal knowledge. It is obvious that the author depended heavily upon published material for the natural history of the various species. It is equally as obvious that he consulted many publications written a decade or two ago which because of subsequent research are hopelessly out of date. Data on Atlantic species are not nearly so incompatible as are those on Pacific Coast fishes, however.

After reading on the second page of the preface that "Never again need the fisherman confuse flounder and fluke * * * " my curiosity was piqued and I just had to know. Eventually, on page 267 under California halibut I found that "Like the Atlantic flukes, this fish faces left * * *." Unfortunately, no one has yet informed the California halibut that it is a fluke and should always face left. As a result, over 40 percent end up facing right.

A few other misconceptions about Pacific fishes that the author has perpetuated include: finding Pacific sailfish as far north as Monterey, California (there are no authentic records of sailfish ever having been taken in California waters); the frigate mackerel "does not have the dots below the pectoral fin which the black skipjack does" (many frigate mackerel do); sierra range from Santa Monica, south (there is no authentic record for a sierra having been taken within 400 miles of Santa Monica); Monterey spanish mackerel are found only off California and are extremely rare (there are perhaps millions of Monterey spanish mackerel in the upper Gulf of California where they provide a wealth of commercial and sport fishing); California (wrongfully called Pacific) barracuda range into the Gulf of California and reach maximum weight of about 10 pounds (there are no authentic records for California barracuda south of Magdalena Bay and many fish weigh 12 to 14 pounds, the record being 17 pounds 6 ounces); California white sea bass range south to Chile, the author having caught them in Peru (white sea bass never range south of the mid-Gulf of California on the Mexican mainland. Peruvian *Cynoscion* barely resemble white sea bass); totuava occur in areas too primitive to be accessible to modern fishermen and they are of value mainly for their air bladders (this information has not been valid for more than two decades); the California yellowtail ranges into waters of Panama, the Galápagos Islands, Ecuador and down to Chile, and the world record is a 105-pound 12½-ounce fish (no California yellowtail has ever been caught south of the Gulf of California and the 105-pound world record is an inexcusable blunder by the International Game Fish Association. When the International Game Fish Association was considering this fish for a record it was pointed out to them that it was not a California yellowtail but a Pacific amberjack. Even so, they ignored the facts and set it up as a record. The valid record for California yellowtail is an 80-pounder); a "rockfish" is illustrated on the plate facing page 309 (it is not a rockfish but a lingcod); roosterfish range southward from Southern California (there is no authentic record of roosterfish approaching within 300 miles of California); etc.; etc.; etc.

Actually, the book has many good to excellent features, unfortunately the multitude of inaccuracies regarding our Pacific Coast fauna throws doubt on the veracity of all statements. It would take the average fisherman hundreds of hours to search out detailed information such as the author has presented. It is doubted if even then the average angler could find this wealth of knowledge. The fine line sketches

that make up the identification charts (pages 425 to 464) are exceptionally well done and could settle a lot of arguments as to the correct identification of a catch.

—*John E. Fitch, California Department of Fish and Game*

Sea Shells of Tropical West America; Marine Mollusks from Lower California to Colombia

By A. Myra Keen; Stanford University Press, Stanford, Cal., 1958; 10 color plates, profusely illustrated with black and white text figures, 624 pp., $12.50.

This volume is a model of planning, ingenuity, and hard work. It not only was meant to be useful, it is useful—from binding to binding.

First (or lastly) the Stanford Press included a plastic substance in the binding so if used in the field, moist hands or a bit of water would not ruin it. Opening the cover reveals, on the end pages, a map of the area covered.

The scope of the volume is the Panamic fauna—some 1,650 species of mollusks reported from shallower than 600 feet, between Magdalena Bay and Colombia. A brief resume of this area—its magnitude, its ecology, its exploration—is presented in a 10-page introduction.

The bulk of the text is occupied with a systematic section in which the shelled members of five classes of mollusks are described and figured. For higher categories the arrangement is more or less conventional, but for lower categories, the sequence of names is alphabetical except for type genera or subgenera which are listed first within their respective families, and so on. Every species of bivalve recorded and described from the Panamic fauna (shallower than 600 feet) has been illustrated and discussed regardless of adult size. For gastropods, an arbitrary size of five millimeters was set as a minimum for detailed coverage. Minute gastropods failing to reach this size are cited by genera only, with representative figures of typical individuals.

The descriptions of individual species are brief yet amazingly complete. Of great importance, is the fact that the figures of the species described are always on the same or facing pages as the descriptions. There is never any need to flip pages looking for the picture of a shell, the description of which is in front of you. The latest acceptable nomenclature is used and the authority, date of original description, and synonyms (when applicable) are given.

For the most part, the illustrations are exceptional for their detail and clarity. Of the 1,650 species described, some 1,500 are illustrated with nearly 3,000 views. About 70 type specimens are figured for the first time. The 10 color plates are masterpieces of color and perfection.

In the appendixes are keys to the families (simplified keys to genera and subgenera are scattered throughout the text on appropriate pages). Also in the appendixes are a glossary, a list of sources and explanation of figures, and a comprehensive bibliography. A 31-page index and four pages of addenda complete the volume.

Without a doubt, this is the finest single-volume monograph of a molluscan faunal province ever published. The modest price for a copy could not have been realized except for a generous subsidy coupled with the author's willingness to have it published as a labor of love rather than for the profit it might have brought.

As with all works as comprehensive as this, one can find errors and omissions, or can take exception to some of the scientific names; however, such oversights and controversial items are few in number and in no way detract from the value of the book. It's purchase is highly recommended for all who treasure items of beauty—be they shells or books.—*John E. Fitch, California Department of Fish and Game.*

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STATE OF CALIFORNIA

FISH AND GAME COMMISSION

Notice is hereby given, in accordance with Section 206 of the Fish and Game Code, that the Fish and Game Commission shall meet on May 29, 1959, in the State Employment Building, 722 Capitol Avenue, Sacramento, California, to hear and consider any objections to its determinations or proposed orders in relation to birds and mammals for the 1959 hunting season, such determinations resulting from hearing held on April 3, 1959.

FISH AND GAME COMMISSION
WM. J. HARP
Assistant to the Commission